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The Public Lighting Tables of the American Meter Company will be found in the page advertisement of that Company.

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[OFFICIAL NOTICE.]

Thirty-third Annual Meeting, New England Association of Gas Engineers.

NEW ENGLAND ASSOCIATION OF GAS ENGINEERS,
OFFICE OF THE SECRETARY,
EAST BOSTON, MASS., Feb. 5, 1903.

Gentlemen of the New England Association of Gas Engineers: The Thirty-third Annual Meeting of the Association will be held at Young's Hotel, Boston, Mass., February 18th and 19th, 1903.

The first session will be called to order at 10 A.M., in Room 12, and members are urged to be on hand promptly, as each year finds it more difficult to dispose of the business presented in the time at our disposal. Members are requested to remit their dues to the Secretary before coming to the meeting, as this will save his time and reduce the chance of duplicate bills.

Application blanks for membership may be obtained of the Secretary, and may be sent in, when properly filled out and accompanied by the admission fee of $5, any time before February 17th, 1903.

The members will dine as usual Wednesday evening, February 18th, in the large dining room of the hotel. All friends of the Association are cordially invited to attend the meeting, whether they get a special invitation or not.

It has been suggested that an exhibit of educational and advertising matter used by the various companies would be of interest and value. If this meets with your approval, will you kindly send to the Secretary, *at once*, samples of flyers, cards, pamphlets, etc., that you may have found useful, so that they may be arranged in convenient form for inspection between the sessions of the meeting.

The following papers, short topics and questions have been sent in:

"An Electrical Disturbance in the Gas Industry," by Mr. D. D. Barnum, Worcester, Mass.

"Methods of Bill Collection," by Mr. S. E. Baker, Fall River, Mass.

"Experience with Incandescent Lighting," by Mr. A. F. Cooper, Exeter, N. H.

"Development of the Gas Distributing System of the Suburban Gas and Electric Company, in Revere and Winthrop," by Mr. A. B. Tenney, Revere, Mass.

"A High Pressure Line," by Mr. W. A. Learned, Newton, Mass.

"In the use of prepayment meters, what methods are adopted for comparing the returns of the money boxes with the actual registration of the meters?"

"Which system of purifiers is proving the more satisfactory, economical and reliable; four boxes with center seal or two boxes of extra depth?"

"What is the relation of Texas oil to the gas business at present?"

"How near to a gasholder is it safe to have a gas lamp?"

"What results have been obtained from the new generator fuels used because of the coal strike?"

"At what point in the works should coal gas and water gas be mixed?"

"Does a mixture of coal gas and water gas give a higher candle power than would be computed from the known proportions and candle powers of the component gases?"

"Of the gas used for lighting what percentage is used through incandescent burners?"

"What results have been obtained with gas oil in 'fixing retorts'?"

"A—How can the gas consumer be induced to read his own meter?"

"B—If he would do this would it not reduce the complaints of 'Big Bills'?"

Please note carefully the "Question List" and come prepared to give intelligent answers to these inquiries, as they are put in good faith, and deserve careful consideration by the meeting. Very respectfully,

N. W. GIFFORD, Secretary.

[OFFICIAL NOTICE.]

Tenth Annual Meeting, Michigan Gas Association.

MICHIGAN GAS ASSOCIATION,
OFFICE OF THE SECRETARY,
ANN ARBOR, MICH., Jan. 12, 1903.

To the Members of the Michigan Gas Association: The tenth annual meeting of the Association will be held in Battle Creek, Mich., on Wednesday and Thursday, February 18 and 19. The headquarters of the Association will be the Post Tavern. Good accommodations are assured to all those who apply in advance. HENRY W. DOUGLAS, Secretary.

[OFFICIAL NOTICE.]

Novelty Advertising Department, Ohio Gas Light Association.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF SECRETARY, DELAWARE, O.,
January 20, 1903.

The Editor of the Novelty Advertising Department, Mr. B. W. Perkins, of South Bend, Ind., desires to announce that his department is

SMITHSONIAN DEPOSIT. FEB 9 1903

now open for contributions, to be presented at the Nineteenth Annual Meeting, which will be held in Cincinnati, March 18th, 19th and 20th.

This department should prove very attractive for the convention. Its success, however, depends largely upon the active co-operation of the members. It is, therefore, earnestly hoped that the fraternity will not be backward in sending advertising schemes to Mr. Perkins.

T. C. JONES, Secretary.

[OFFICIAL NOTICE.]

Wrinkle Department, Ohio Gas Light Association.

OHIO GAS LIGHT ASSOCIATION,
OFFICE OF WRINKLE DEPARTMENT.
ST. PAUL, MINN., Jan. 17, 1903.

This department earnestly solicits the co-operation of the fraternity for contributions, to be presented at the Nineteenth Annual Meeting of the Association, which is to be held at Cincinnati, March 18th, 19th and 20th.

The Editor will be pleased to receive contributions not later than February, 14th.

E. E EYSENBACH, Editor.
Care St. Paul Gas Light Company,
St. Paul, Minn.

[OFFICIAL NOTICE.]

Wrinkle Department, Western Gas Association.

WESTERN GAS ASSOCIATION,
OFFICE OF THE WRINKLE DEPARTMENT,
721 Citizens Building, Cleveland, O.

To the Members of the Western Gas Association: The Wrinkle Department is now ready to receive contributions for the 1903 collection, and I would thank you to please send a sketch or description of any new device or method you may have to the above address.

Any sketch, photograph or drawing, accompanied by a written explanation, of a new idea will be gratefully received, and it is hoped that you will comply promptly by favoring us with a contribution.

Respectfully, W. E. STEINWEDELL,
Editor Wrinkle Department.

BRIEFLY TOLD.

NOTES.—

WILFORD R. WOODROW, who pleaded guilty to the charge of having embezzled $1,500 of the funds of the South Jersey Gas, Electric and Traction Company, has been sentenced to a term of two years in the New Jersey State prison.

MR. EDWARD J. BURKE, formerly in the employ of the Joliet (Ills.) Gas Light Company, has been appointed Superintendent of the Marquette (Mich.) Gas Light Company.

AT the annual meeting of the shareholders in the Washington (D.C.) Gas Light Company the following Directors were named: John R. McLean, James W. Orme, George T. Dunlop, R. H. Gouldsborough and John McIlhenny. The annual report of President McLean showed that the Company had, in the twelvemonth, enjoyed the most prosperous trading in its history.

AT the annual meeting of the Equitable Gas Company, of San Francisco, the following officers were elected: Directors, Chas. L. Ackerman, Leon Blum, S. H. Lacy, Frank Pauson, F. C. Siebe, Joseph Naphthaly and Albert Ceri; President, C. L. Ackerman; Vice-President, Leon Blum; Secretary, S. H. Lacy; Treasurer. Frank Pauson.

THE City Council of Boise, Idaho, has granted a franchise to the promoters of the Boise Gas, Light and Power Company, under which the latter are authorized to construct and operate a gas plant in the named place. The Company agrees to pay into the city treasury the sum of 1 per cent. on its gross receipts from the sale of gas, and agrees to commence construction work within 8 months from the date of its acceptance of the ordinance.

MR. JOHN FULLAGAR, son of Mr. W. E. Fullagar, of Rutherford, N. J., has been appointed to a responsible position in the counting room of the Camden division of the South Jersey Gas and Electric Company.

THE Capital City Gas Company, of Montpelier, Vt., announces that its selling rates will range from $2 per 1,000 gross to $1.10 net, according to monthly consumption. No bill will be rendered for less than 50 cents per month.

MR. EDWARD E. PIERCE, of Narragansett Pier, R. I., writes us that the South County Gas and Power Company is preparing to install a gas plant in Narragansett, and he would be pleased to receive communications regarding processes, apparatus, machinery, etc.

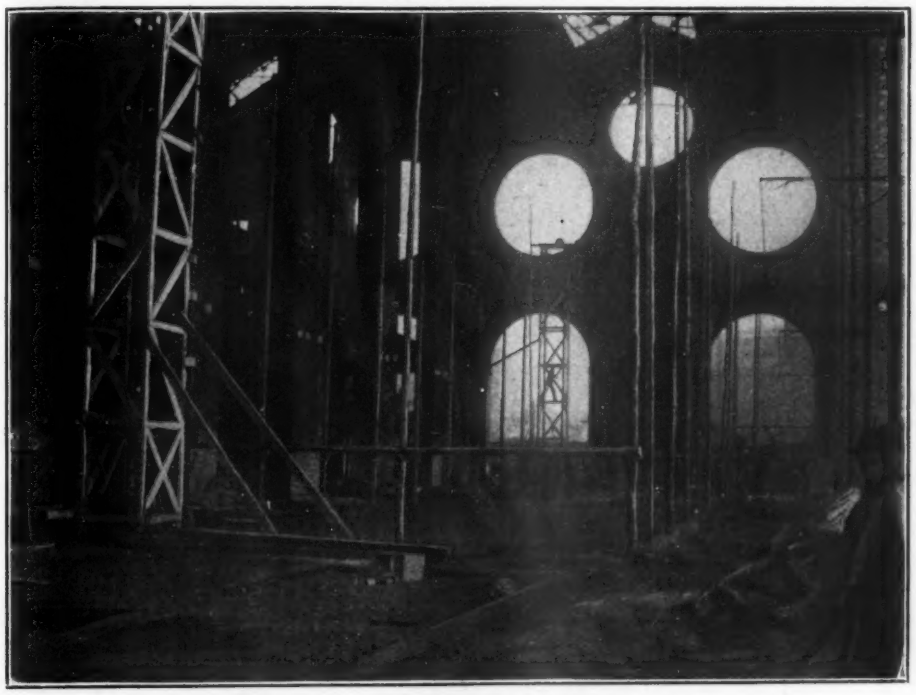
An English Inclined Retort Installation in Milan, Italy.[1]

In keeping pace with the development in adoption of the inclined retort system, we have this week to turn attention to the large installation that has lately been completed at the Milan Gas Works for the Union des Gaz, with which, as many readers know, the Continental Union Gas Company are practically affiliated. In dealing with these new installations of the inclined system of carbonization, it is always our aim to unearth, for the general benefit and pleasure, their distinctive features, and any points that will awaken curiosity and interest in the work and its future. This Milan installation of inclined retorts and the auxiliary coal and coke handling plant, it is found, possess attractive characteristics—inherent and external; and, being an importation and not native, some of the circumstances attending the rearing of the plant will, in their narration, prove more entertaining to the reader than, we undertake to say, they were at the time to the contractors, Messrs. Graham, Morton & Company, Limited, of Leeds. The fact that an English firm obtained the contract for the work in Italy supplies at once a point of interest for all English readers; and, when it is mentioned that the house is the first on the Continent equipped with 20-foot inclined retorts, sufficient has been said to assert its claim to something more than passing notice. Considering the conditions under which the work was carried out, the fact that the contractors succeeded in completing the building of 32 beds of 20 feet inclines, and in bringing to the working state the whole of the extensive conveying plant rendered necessary by the magnitude of the retort installation, within the space of 7 months from the laying of the first brick of the settings, supplies a testimonial to skill and to eminent organization which merits here a word of hearty congratulation.

Difficulties Encountered and Overcome.—Allusion has been made to the difficulties which the execution of a contract encounters so far from the seat of operations; and perhaps of all the western or southern countries of the Continent there is not one that opposes such intestine obstacles to the rapid progress of work of this large character as Italy. We will only mention one of the difficulties. The whole of the material, except a small portion of the fire clay goods, was shipped from England—the bricks from Glasgow, and the ironwork from Leeds. The time occupied in the transmission of the heavy material—from the date of its dispatch to its arrival at Genoa—averaged 3 weeks for each consignment, including the passing through the Customs. The length of that period was not by any means a matter for complaint; but it was directly the goods arrived at Genoa that the trouble commenced. Even the poignant criticism and sarcasm expended upon the railway companies of this country would not suffice to meet the state of things that exists in Italy. The shortage of railway wagons is a perennial trouble; and this is more particularly felt during the season when the Italian Government take over the wagons for the transport of fruit. However, in this case, Messrs. Graham, Morton & Company did their best to get the bulk of their material over before that season arrived. Nevertheless, although only 3 weeks were spent in getting goods from Leeds to Genoa, as a rule about 7 weeks had passed from the date of the start on the journey before their safe delivery in Milan. However, handicapped as the contractors were in this regard, the works were completed in as many months as it took weeks for the passage of each shipment of material.

But there is also another considerable difficulty in the execution of a contract of this kind in a foreign land, and that is with respect to labor and language. The firm, in this instance, took out to Italy sixty of their own trusty retort setters—men all experienced in the setting of inclined retorts; most of them, in fact, having come direct and fresh from the large performance at Granton. Later on as the installation progressed, and the character of the work changed, some of the retort setters were replaced by English mechanics. But altogether it may be taken that during the time the 60 English workmen were on the "job" there were over 300 Italian workmen employed; or a proportion of about five Italians to one Englishman. And, on the whole, it must be recorded, they worked together well and with good temper. It is interesting to get an insight into the methods adopted by contractors under such circumstances as these; and although it does not directly come within a descriptive account of the work under notice, we venture to briefly state what was done in this case. The language difficulty was got over by the firm engaging two interpreters—one being allotted to the staff and one to the workmen; and, in addition, ten Italian bricklayers who spoke English were found very serviceable. Also, with the view of rendering the men to an extent independent in this

1. Text from *Journal of Gas Lighting*; illustrations by permission of Mr. Maurice Graham.



March 1, 1902.—The Day the First Brick of the Settings was Laid.

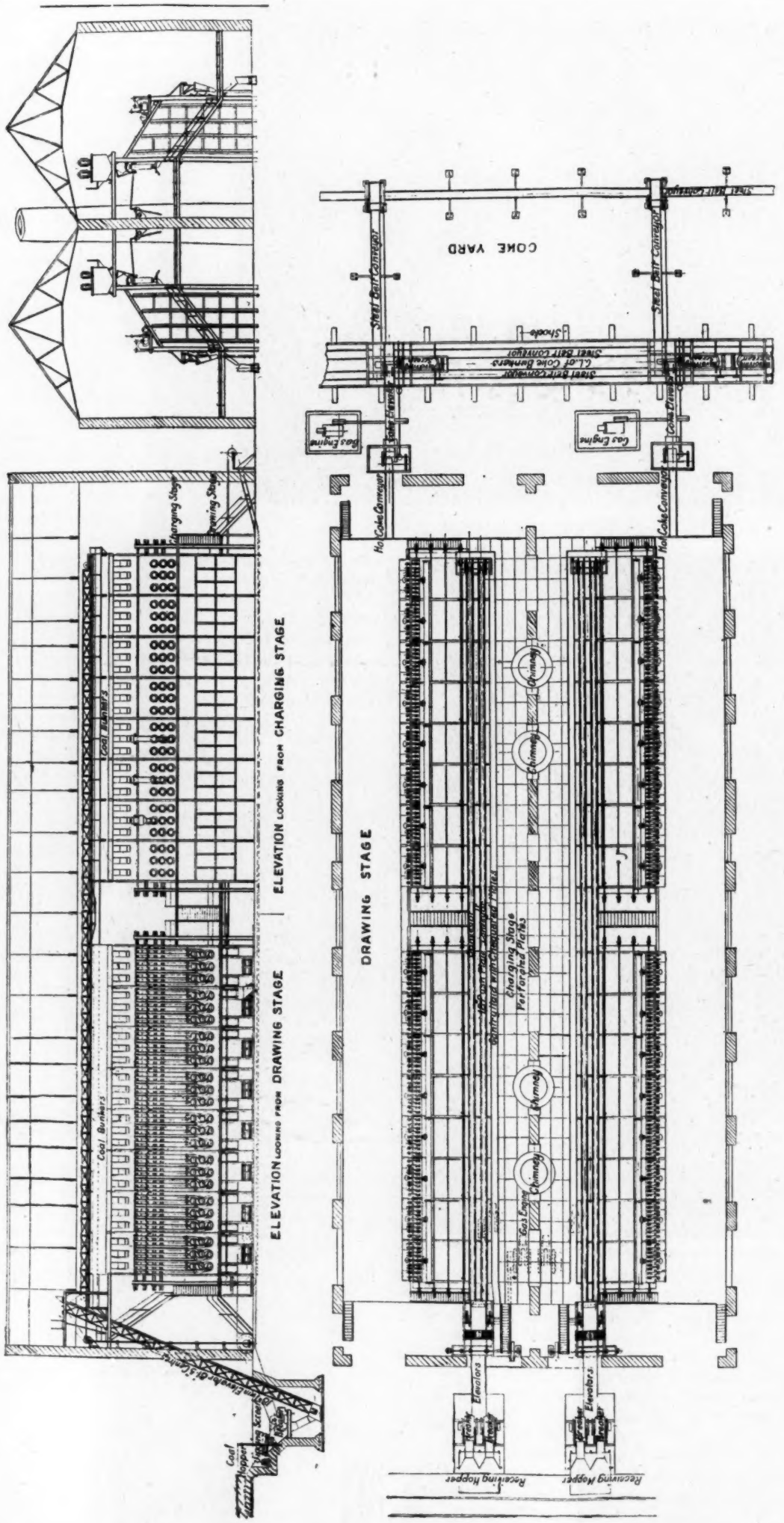
April 15.—Six and-a-Half Weeks' Work.

matter of language, the contractors had specially prepared a *vade mecum* in the form of a dictionary, containing a complete list of words and phrases applying to the various portions of the plant. Then the feeding arrangements for the English workmen were a matter of some concern to the contractors, who bore the expense of catering for them in the gas works yard, according to an agreement entered into before the men "signed on." The meals were controlled by two *chefs*. During the first part of the contract, Italian food was served. But this did not suit nor did it satisfy the English workmen's palate and appetite. It was soon supplanted by English diet. Sleeping accommodations, too, had to be considered; and this was provided in large barracks so that the men were kept together as much as possible. In fact, every reasonable attention was given, and very properly, to the men's personal comfort. Remembering the great variations of temperature experienced in this part of Italy, and considering also the fact that the men were not accustomed to working in such an excessively hot climate, the contractors had reason to be highly gratified with the manner in which their English employees worked, and particularly, in view of the cheapness of wine in the country, their temperate conduct. In addition to the workmen, there was an engineering and clerical staff of 8 persons; and during the execution of the contract Mr. Maurice Graham himself paid no less than 12 visits to Milan in order to inspect the work as it progressed.

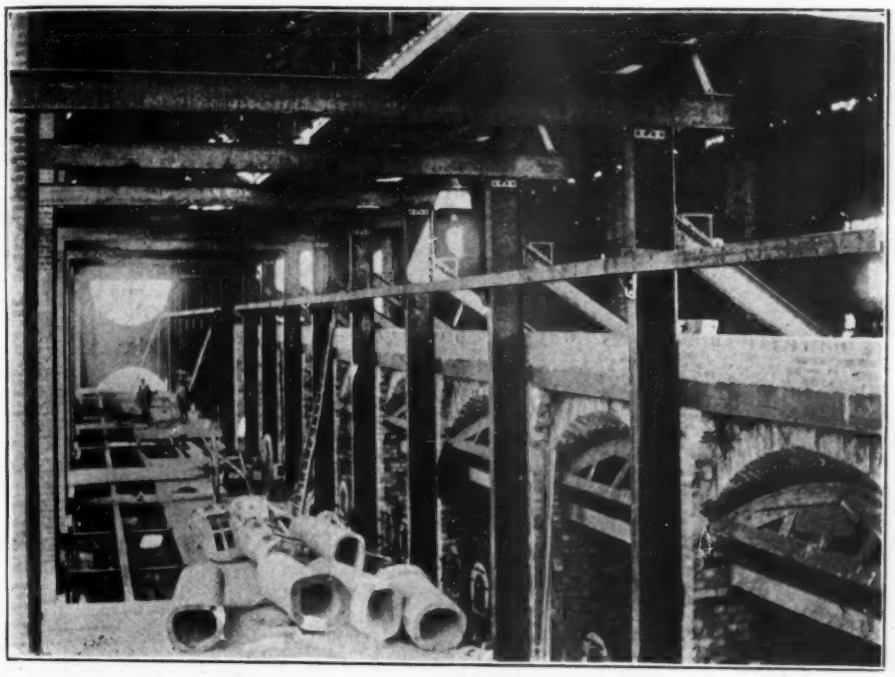
These matters show the amount of foresight and organization that are necessary prior to undertaking a contract of this kind and extent so far from the place at which the structural material and parts are produced, and the subsequent active attention to detail required at both ends, to insure smooth working. But the transport of the material, the manning of the job, the lingo difficulty, and the feeding and lodging of the men do not exhaust the preliminaries to the carrying out of such a contract. There are the contractors' tools and tackle to be taken from home to the far distant scene of the work; and in this case the value of this plant may be put down as equal to a round £3,000. Besides the vast stores, a mechanics' shop had to be fitted up in the yard complete with lathes, drilling machines, punches, fitters' benches, etc.; and a compressed air plant, with automatic riveting hammers, drills, etc., had also to be provided. Two steam cranes—a 5-ton and a 3-ton one—had to be sent from England to Milan; and a system of wide gauge rails had to be laid so as to bring the railway trucks direct to the spot where the work was in progress. Running round the yard a narrow gauge railway had also to be laid. This is a particularly convenient auxiliary in the case of the building of extensive retort benches, as the enormous space taken up by the amount of fireclay material stacked in the yard demands quick and ready means of transport from the yard to the settings. In the erection of the benches, too, the same system as that adopted at Edinburgh was provided for handling the bricks and raising them on to the scaffolding. Twelve lifts of 4 feet square were fixed at the end of the benches; and the small brick trucks were run from the narrow gauge railway on to the hoists, raised, and then ran along a narrow gauge railway fitted to the scaffolding the full length of the benches. By this means sufficient bricks could be raised to enable each man to handle his estimated quantity. The rapid progress of the work will be observed by a glance at the dates appended to the photographic illustrations.

Description of the Inclined Installation.—The contract which Messrs. Graham, Morton & Co. obtained comprised the equipment of what are to all intents and purposes two complete houses (each being 254 feet 3 inches long by 55 feet 9 inches wide inside the walls, which are 49 feet in height), together with the complete coal and coke handling plant. In each house are erected 16 beds of 9 retorts each; so that in all the new installation consists of 288 retorts. Between the two long lines of settings runs the charging stage, which is the link connecting the two houses. This will be clearly seen by the drawing, page 204. The house itself, which was built by a local contractor, is of the ordinary local yellow brick, with iron roof, and covered with local tiling, there being no attempt whatever at ornamentation. Incidentally, it may here be mentioned that, adjoining the new installation, is one of 16 beds of inclined retorts; but these are only half the length of the new comers. The foundations for the settings were constructed by the Gas Company; and for all above those foundations—from the designing of the work to its execution—Messrs. Graham, Morton & Co. were entirely responsible. As stated in the introductory paragraphs, the whole of the ironwork was shipped from England; and the larger portion of the bricks from Scotland—the inside material for the furnaces, as well as the retorts, being obtained from Messrs. Lachomette, of Lyons. These retorts, we have heard engineers experienced in Continental work say, are of the finest to be obtained in the world. They are made by hand, of ground firebricks and fireclay. The furnaces are of Messrs. Graham, Morton & Co.'s special design, and are so arranged that the bottom bullseye does not receive any heat by induction from the producer. The consequence is that there is no possibility of it being burnt out as in the old style of settings of 9's. The arches are 12 feet centers. The retorts are of D section, with slightly inclined sides, so that the roof of the retort is wider than the floor, which again is slightly dished. Then the retorts are

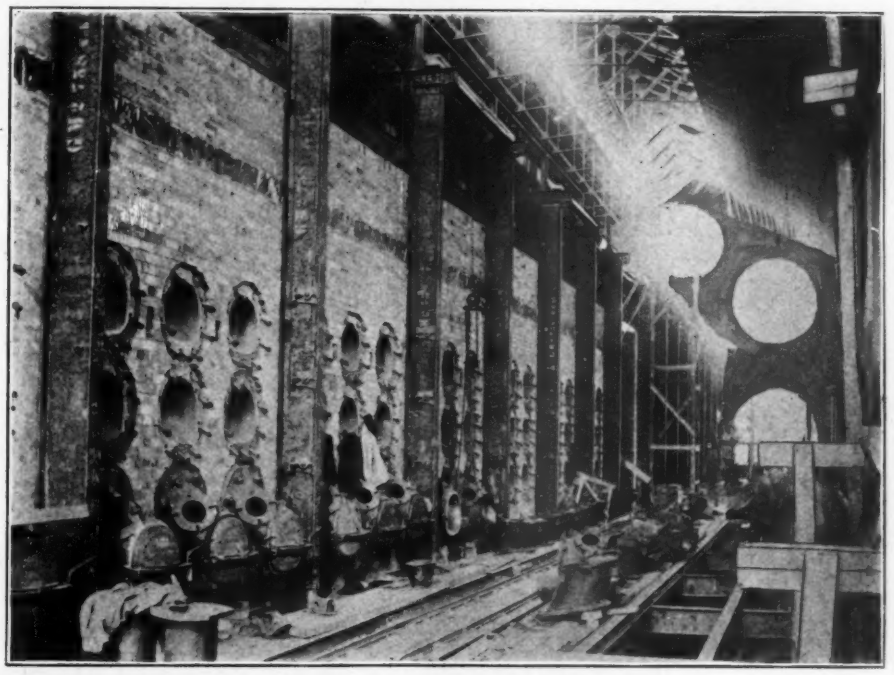
THE NEW RETORT HOUSE AT THE MILAN WORKS OF THE UNION DES GAZ.



Elevations, Section and Plan of the Installation of 32 Beds Inclined Retorts.



June 19.– Position of the Work on the Charging Stage—Setting the Retorts.



July 12.—View of the Drawing Stage—the Retorts in.

—in fact, they are, save for the curved bottom, similar to the Edinburgh pattern.

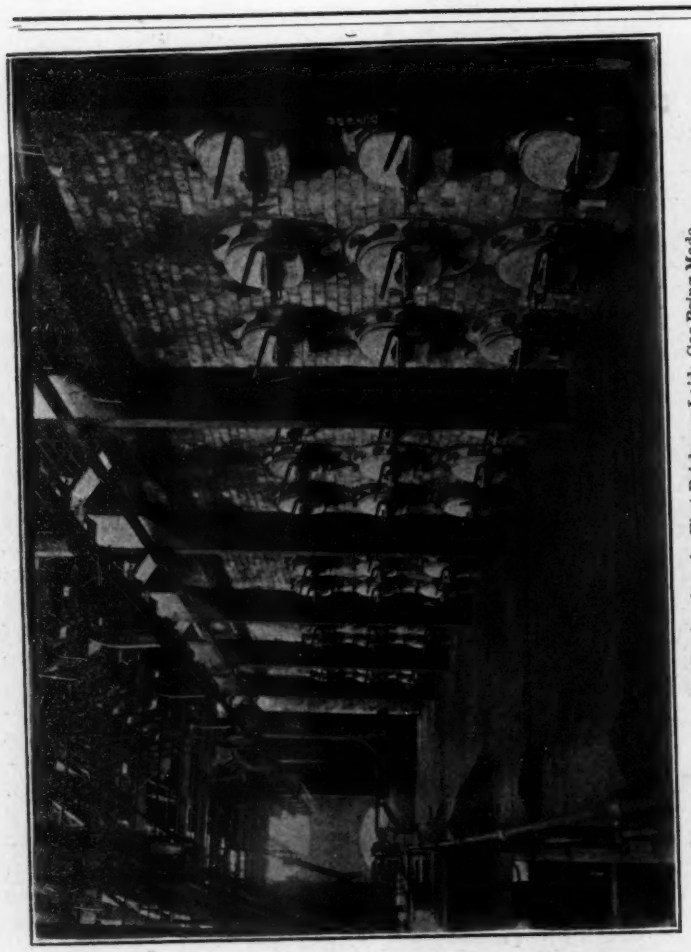
At the charging end, the retorts are 1 foot 6 inches wide, narrowing down to the floor to 1 foot 4½ inches. The extreme depth is 1 foot 4½ inches. At the drawing end they are 1 foot 10 inches wide, narrowing down to the floor to 1 foot 8½ inches; so that the taper to the sides is the same as at the top end. The depth of the retort is the same throughout its length; but the width increases by 4 inches. Before leaving the brickwork, it may be mentioned that each bench of 8 beds has its own chimney; so that the house is fitted with 4 chimneys altogether.

These are located, as will be seen on the drawing, in the center of each half of the drawing stage.

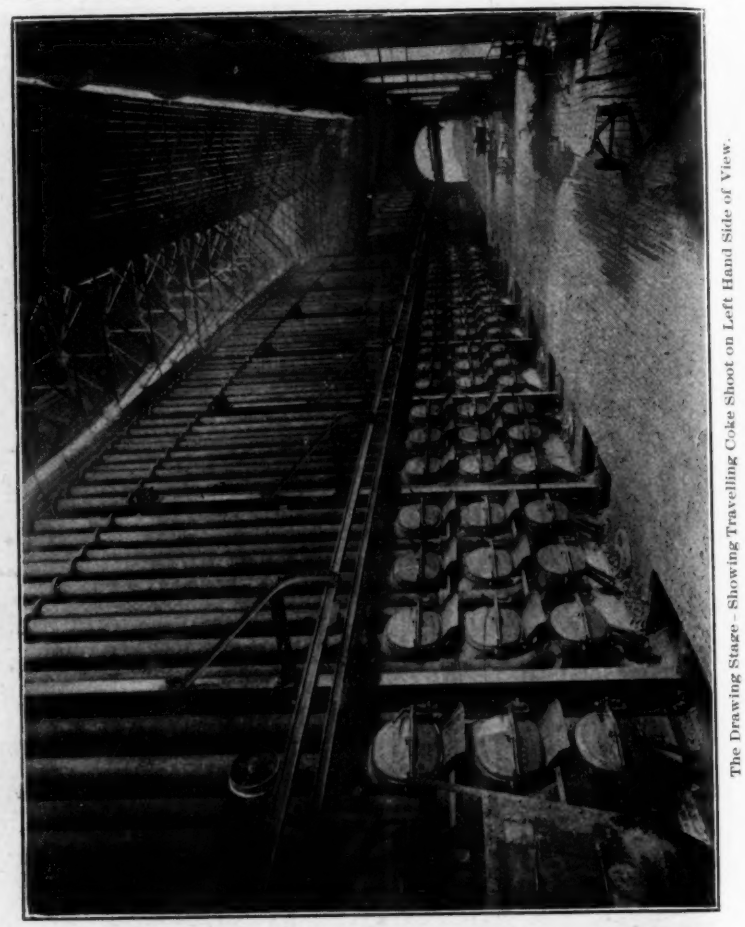
Regarding the ironwork and fittings of the benches, the longitudinal tie-rods are provided with buffer springs, which allow 3 inches expansion at each end, making 6 inches in the total length. The end buck-stays are each made of two 15-inch by 6-inch rolled steel joists; 4 buck-stays, fastened together by means of horizontal 6-inch by 5-inch steel joists, comprising the bracing for the ends of the benches. The front and back buck-stays are of 16-inch by 6-inch rolled steel joists. The front mouthpieces are braced and supported by H-irons; but there is no bracing and support to the top mouthpieces, as it is not longitudinally tapered just sufficient to assist the discharge of the coke considered necessary. The cross bracing is composed of 10-inch by 6-inch rolled steel joists; and at the lower end a horizontal bearer 8 × 6 inches is fixed, so as to carry the hydraulic main and fittings. The tar arrangements are also on the Edinburgh plan. The ascension and bridge pipes are 7 inches in diameter. The hydraulic main has a flat floor, and the dip pipes descend to within 3 inches of the bottom. The outlet of the hydraulic main valve is arranged with a weir, under which the tar flows and the gas over the top. The hydraulic mains are tested every day for the presence of thick tar and pitch; and, on an accumulation occurring, the mains are immediately flushed, for which complete provision is made. The whole of the tar from the hydraulic mains passes through the hydraulic valve into the foul main, there being a separate tar connection for each bed. The foul main is 20 inches in diameter, and is built up of 3-inch by 3-inch by ¼-inch angle iron and $\frac{3}{16}$-inch steel sheets, with the necessary provision for clearing out. The tar flows to the end of each bench, and down a vertical pipe into the siphon pot. All the tar pipe connections are 8 inches diameter.

Now as to the construction of the stage floors. The charging stage is composed of 12-inch by 6-inch main cross girders, crossed by longitudinal girders 6 inches by 5 inches, and covered by wrought iron chequer plates. Down the center perforated plates are fixed for ventilation purposes. The drawing stages are made up of wrought iron I steel joists, 12 inches by 6 inches, with longitudinal girders for carrying the floor made up of 6-inch by 5-inch joists. The whole is filled in with concrete arches, set in cement, and covered with earthenware tiles, in order to keep the floor as cool as possible.

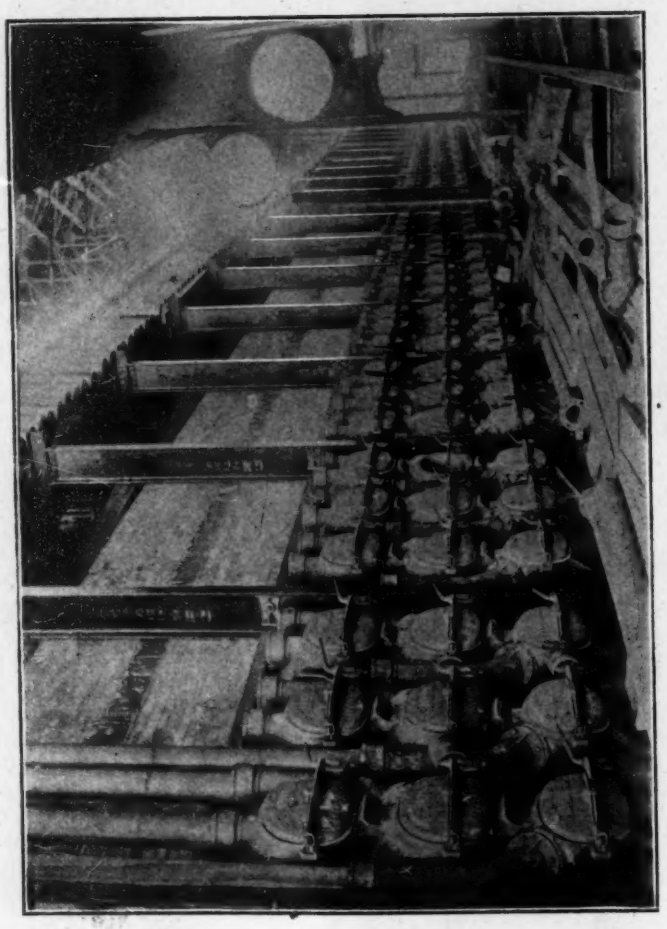
The drawing stages are supported on one side from the benches, and on the other by the walls of the houses. The charging stage for each bench is 18 feet wide; the drawing stage 20 feet 9 inches; and, with the bench 17 feet wide, we have the 55 feet width of each house. The usual stairways are provided at the ends and center of the benches. The coal handling plant is in duplicate for each bench; and each set is capable of dealing with 20 tons of coal or cannel per hour. In other words, the two sets to each bench have a combined capacity of 40 tons. The coal is brought in by railway wagons, and dumped into a 12-foot square wrought iron hopper of the breeches type. Underneath the hopper there is a jigging screen, for the purpose of screening the coal, and also for feeding it continuously and regularly into the breakers. There is a coal breaker of the ordinary jaw type under each leg of the hopper; and these are capable of breaking 20 tons of boghead per hour. (Parenthetically, it may be stated that the coal used is Durham, and by the the time it reaches Milan there is little need of crushers.) By means of a connecting shoot of the usual double breeches type, arranged with a flap door, the coal may be taken from either of the breakers, and fed into either or both of the elevators. As will be seen by one of the photographs, there are two 18-inch lattice-braced bucket elevators, having 74-foot centers, and built side by side in the form of a twin elevator. A wrought iron breeches shoot has been provided at the head of the elevators, and this is arranged to lead the coal from either or both of the elevators, and discharge it into either or both of the conveyors. The conveyors are 18 inches wide, of the push-plate type, and each 206 feet long center to center. The conveyors are supported on the tops of the coal storage tanks, and are provided with 32 outlet slides and doors so as to discharge the coal into the latter. Wrought iron ladders and gangways are arranged for giving access to all this plant, which is driven by two powerful Crossley gas engines. The coal hoppers are in two lines of the continuous type, each line storing and supplying the



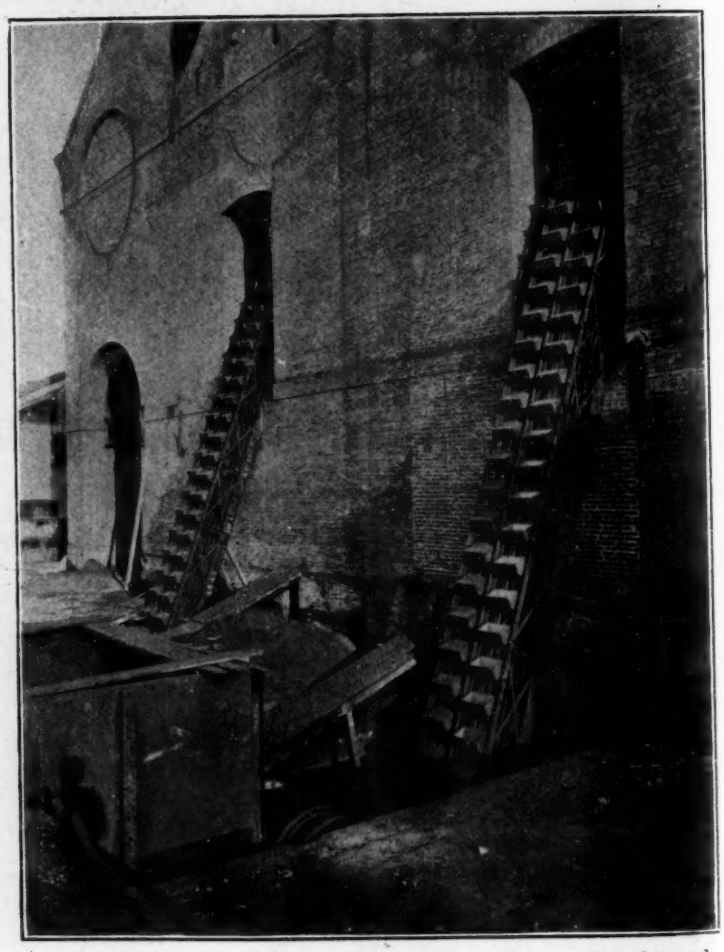
Oct. 1.—Seven Months after the First Brick was Laid: Gas Being Made.



The Drawing Stage - Showing Travelling Coke Shoot on Left Hand Side of View.

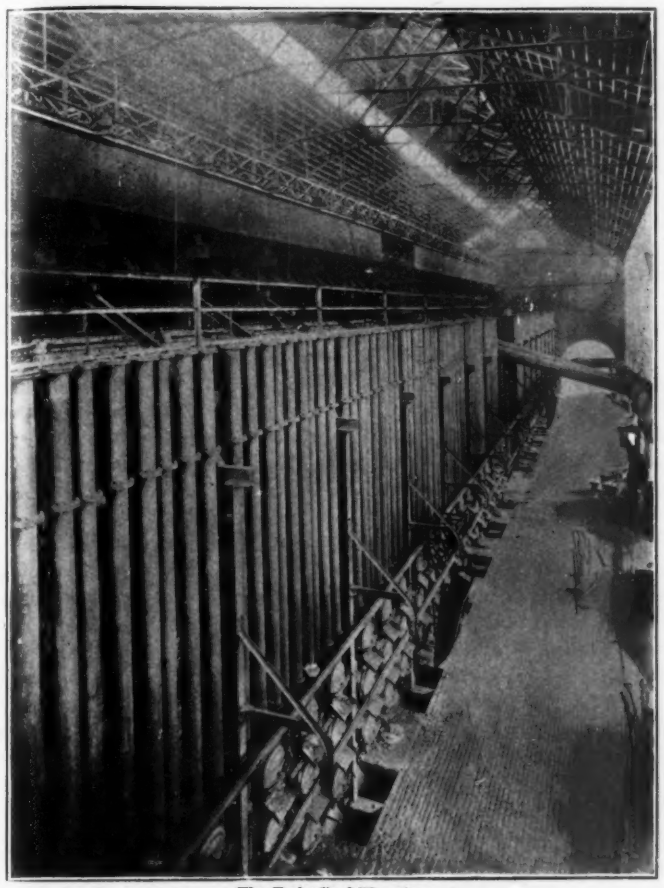


July 28.—After a Further 16 Days.



A Top View from Drawing Stage Side of House—Showing the Long Coal Bunkers and Conveyors.

coal required for 8 beds of retorts. Each hopper is 96 feet long by 8 feet by 8 feet, and is capable of storing 24 hours' requirement of coal. Along the top outside edge of the hopper running the full range of the 16 beds is an inspecting platform, 2 feet 6 inches wide. In the bottom of each 12-foot bay of the hopper there are three openings for the measuring chambers. To each bench of 16 beds are fixed 48 measuring chambers of Graham's improved pattern, with his improved sure-feed apparatus. Each 8 beds are furnished with a set of 3 charging shoots of the same design as has been adopted at Edinburgh (Herring & Graham's patent), with a movable shoot on the bottom, which can be adjusted from 30° to



The Twin Coal Elevators.

60°. For the second bench of 16 settings the coal handling and feeding plant as here described is in every respect similar.

Descending now to one of the drawing stages, it is noticed that suspended from a light rail running in front of the benches are shoots (which are patented) for diverting the hot coke down the shoots formed in the stage at each side of the buckstays, on to the hot coke conveyor situated below. The arrangement is a simple one; and in its very simplicity lies its value. It is illustrated in two of the photographs of one of the drawing stages as completed. In connection with the hot coke conveyor, a deviation from the usual practice is noted. The troughs are not suspended from the stage as is ordinarily the case, but are situated in the ground in the basement. There are two reasons for this—first, to secure uniformity, owing to the inclined settings previously installed having outside producers, which made the introduction of any coke plant difficult; and, secondly, in order that the drawing stage might be left as cool as possible during the great heat of summer. It should not be forgotten that the variations of temperature in this part of Italy are extreme. Last summer over 90° in the shade was registered; and during the present winter there has been 4 inches of snow, and far colder weather continuously than in this country.

The coke plant installed at the works is on an extensive scale; but we must reserve the interesting details connected with it for a future article.

The photographs that are given this week not only illustrate the character of the work, but the dates on which they were taken testify to the rapid progress with which the construction of the large plant was accomplished by the contractors.

[To be continued.]

Gas Fuels for Modern Engines.

By Mr. George E. Walsh, in *Iron Age*.

Advance in Engines of Large Units.—The development of the gas engine in the past year or two has brought to the front the different kinds of gases as important factors in the fuel situation. In this country gas engines have tardily waited upon their development and improvement abroad, but within the year just closed there has been sudden activity shown in connection with them that promises many changes in the near future. The lack of general practical interest in gas engines in this country until quite recently has been due to the fact that experimenters were unable to produce a machine of large unit power which would work continuously under nearly all load conditions. A small unit gas engine was, theoretically, all right, and for laboratory and experimental purposes eminently useful, but in the field of actual labor it did not count.

We have to-day the perfected gas engine of large unit power, and the improvements are rapidly placing the new engines in the competitive list with steam engines. Moreover, the development of the steam turbine has called attention to the possibilities of the gas turbine. This latter, if evolved, might prove the ideal engine for developing power in the future, and the whole field of manufacturing would be revolutionized thereby. The gas turbine, however, is something for the future to demonstrate, and for the present the almost insurmountable difficulties in the way indicate that the machine will remain in the experimental field for some time to come. The confidence expressed by many leading experts that the gas turbine will be realized within the present decade indicates that science will probably overcome all questions involved.

But the steady increase in the use of gas engines of large units brings home to us the possibilities of the gas supply in the United States. The gas engines will, in this country, be grouped somewhat according to the fuel they will consume. Ordinarily this fuel will be understood to possess certain ingredients whose powers of combustion can be estimated by simple calculation. But it should be remembered that gas differs in burning and heating power far more than coal, oil or almost any other well-known fuel. Gas is nothing unless its potential power can be definitely measured.

Engines Operated with Natural Gas.—In classifying the gas engines in this country, according to the fuel they will use, the great Central States, where natural gas is still a determinate factor in the manufacturing interests, will steadily draw chief attention to the engines belonging to the first group. There has been for years a steady decrease in the supply of natural gas throughout the Middle Western States, and the rock pressure has in some places become so insignificant that the gas wells have been entirely abandoned. On the other hand, the invention of new pumping machinery has partly compensated for this lessening pressure, and it has been found possible in some of the old gas regions to secure a full gas supply at little more cost than when it spouted up freely in great quantities. The loss of the gas then was tremendous, but to-day waste is almost entirely eliminated, and every cubic foot of natural gas is utilized.

The chief question involved in the use of gas engines of this group is how much natural gas does the earth contain, and is the supply inexhaustible if better and more powerful pumping engines can be invented to draw it up from the interior? Some scientists assure us positively that the supply is unlimited, and that if engineers can keep pace with the consumption of the gas in inventing new methods of tapping the great underground reservoirs there will never come a time when it will be exhausted. The theory that the supply is constantly being renewed, and that at almost any day the borers may strike a new reservoir which will spout up more natural gas than the world can use in a hundred years, certainly proves very favorable reading to those interested in the subject.

The natural field for the gas engines of this group is to show their efficiency in pumping up the gas fuel for manufacturing and household uses. Consequently we find in the natural gas regions giant gas engines employed to operate these pumps, and they stand as practical demonstrations of the utility of the modern gas engine. They have come to replace the old coal steam pumps almost entirely. Gas engines of very large units have been erected for burning natural gas, both directly on the field and at great distances from it. The delivery of the natural gas in pipes has in recent years shown a tendency to limit its field. The natural loss through long pipe delivery has caused manufacturers to group their industries as near the field of supply as possible. With the improvement of the gas engine it is believed that in a short time all the natural gas will be used within a radius of 10 or 20 miles of the wells. The saving obtained in this way will prove an important item.

The building of enormous gas compressors to facilitate the efficient and satisfactory delivery of the natural gas to the surrounding towns and factories has been a feature of the operating work, and there is in progress now the construction of some of the largest gas compressors in the world. Two of 4,000-horse power are being built and several of 1,000-horse power. These engines are operated economically with natural gas fuel, which enters the cylinder at almost atmospheric pressure. The engines deliver 1-horse power in the compressor cylinder on 8 to 9 cubic feet of natural gas per hour. The larger engines of 4,000-horse power accomplish about the same results on a consumption of about 7.50 cubic feet of natural gas of 1,050 British thermal units.

Under the tests and experiments made everything depends upon the supply of natural gas as to whether this form of engine will continue in service. The engine is easier tr operate than one run by coal, and its ability to start up and shut down quickly without loss of any kind recommends it for many kinds of work.

The establishment of more adequate pumping stations and compressors naturally appeals first to engineers interested in the development of gas engines of large units intended for operation by the natural gas fuel. The mammoth pumping engines have already demonstrated the possibility of continuing the use of natural gas for indefinite years in the future. Few indeed of those who own natural gas wells, or manufacturing establishments operated by this fuel, show any doubts about the future certainty of their supply. The impression rather prevails throughout the natural gas region that the supply will tend to increase through better methods of obtaining and utilizing it and through the gradual adoption of methods to eliminate the present loss and waste.

Engines Adapted to Use Poor Gas.—The gas engines of the future must be able to adapt themselves to all kinds of gases, from the richest gases of distillation to the poorest products of the blast furnace. Between the two extremes there are many kinds and qualities of gas which must be successfully utilized by the construction of engines peculiarly adapted to their use. Through the adoption of better mechanical methods this change from rich to poor gas is obtained. It has been found that a little modification of the proportions of the explosive mixture and a proper regulation of the degree of compression and the ignition period obtain these results. Gas engines operated by producer and illuminating gas represent a much wider range of usefulness than those dependent upon natural gas. In our cities gas engines belonging to this group have possibilities scarcely yet measured. From one part of the country to another the gas engine would have its fuel supplied at all times for its operation. The manufacture and distillation of this gas vary considerably in different parts of the country and in different contiguous cities. Likewise the cost of the gas differs so widely when supplied in quantity to the engines that one can figure upon the cost of operation only by ascertaining in advance the charges demanded by the gas companies. The charges for city gas in American cities run all the way from $0.54 to $1.35 per 1,000 feet; but it will be seen that the difference in the price is not so great when the quality of the fuel is considered. This runs from 100 calories per foot up to 200. In the Southern cities, where the distillation is chiefly from dry wood, the quality expressed in energy is small, while in the Eastern cities and coal regions, where the distillation is chiefly from coal and schist, the highest energy is obtained. While both extremes of quality are found in different parts of the country, the average gas is placed between 130 and 160 calories.

The cost of producer gas for operating gas engines is further modified by some figures obtained from careful experiments. These figures, it is true, were obtained from tests made with small horse power motors, but they apply approximately to the larger unit gas engines. The larger the engine operated the greater is the percentage of efficiency and saving of cost of fuel.

Thus a 4-horse power engine operated by gas costing $0.54 per 1,000 feet would cost per horse power for each hour of continuous operation about $0.022, while a 10-horse power engine would reduce the cost of operation to $0.019, and a 30-horse power engine could be run at an average of $0.017. In considering gas at higher prices, it must be assumed that the quality is in proportion to the increased charges. With gas at $0.81 per 1,000 cubic feet the 4-horse power engine could be operated at $0.028, the 10 at $0.025 and the 30 at $0.023. With gas at $1.35 the cost of a 30-horse power machine would approximately be $0.035.

With city gas at the highest figure the gas engines could be operated fairly satisfactorily, and even at $1.10 per 1,000 feet the gas engine would prove a successful competitor with any other engine built. Without considering the convenience and other advantages of the gas engine, this form of power production on a small scale would prove superior to almost any other, and even with permanent gas engines of large unit power the advantages would be immeasurably great. The portable gas engines in cities are at present the most popular. These average 10 to 20-horse power, and their efficiency in doing work on the streets, in subways and for building purposes is unequaled.

The consumption of city gas for power purposes is not great in any of our American cities at present, but the steady and increased use and manufacture of the engines show that within even the current year the change will be quite great. In Germany the gas engine has been popular much longer than in this country, and the numerous gas engine shops are crowded with orders. In a great many of the manufacturing German cities the consumption of gas for operating these engines runs as high as 15 and 18 per cent. of the total product. In Paris from 3 to 5 per cent. of the city gas is utilized for the same purpose. There is hardly a city in this country which has 1 per cent. of its gas product utilized for operating gas engines, although the consumption is increasing so rapidly that this statement may not long be true.

The reduction in the cost of gas distillation directly affects the usefulness of the gas engine, and to a considerable extent determines its future. The cost of coke, anthracite and wood must always be an influential factor in this work, but the modern methods of distillation indicate that improvements will radically alter existing conditions in gas manufacture. The present is not a favorable moment for considering such a reduction in cost; but, despite the present upward tendency of both of coke and coal, it cannot be questioned that both of these fuels will go down again. Meanwhile, the effort to use them in less quantities to obtain suitable gas has been of inestimable value. The prohibitive price of any staple article always tends to open ways for getting along without it. Substitutes are bound to be discovered, and science gradually shows that what was formerly considered an absolute necessity is after all more or less of a luxury.

Furnace Gas Engines.—The construction of gas engines to burn the gases of blast furnaces probably represents even more important economical changes than those for utilizing either natural gas or producer and illuminating gas. Germany has held undisputed supremacy in the development of this form of engine in the past few years, and we are just beginning to profit by her experiments. Engineers look to the German operators for their designs and tests with the blast furnace gas engines, but now that they are perfected it will not be long before a complete change will be effected in this country. With our numerous blast furnaces scattered all through the country, it is essential that the installation of engines to utilize the waste gas should be made at once. The gas engine of 1,000-horse power is no longer a dream. It has been steadily developed and improved by the tandem system, so that it can be operated by blast furnace gas of but 27 calories per cubic foot. As a result of this development the blast furnace suddenly assumes an entirely new line of development. It may be that the production of pig iron will in the near future become only of secondary consideration, and the gas for operating engines the chief factor of the works. The blast furnace gases are sufficient to run powerful engines even when discounting half for waste and for heating the air blast of the furnace.

The amount of gas generated by a blast furnace to produce pig iron is so enormous that if collected and utilized for power purposes it would prove revolutionizing in manufacturing industries. Thus to broduce in an ordinary well equipped works about 150 tons of pig iron the blast furnace would generate upward of 20,000,000 cubic feet of gas. To harness this enormous amount of waste fuel is the aim of the builders of gas engines. Utilized for generating steam by burning, about 1,000-horse power could be obtained; but if burnt directly in a modern large gas engine the horse power generated would be several times as much. Eminent engineers estimated that even if half this volume should be wasted or used for heating the air blast of the furnace there would still be sufficient to produce between 3,000 and 4,000-horse power. Such an enormous gas generator would thus prove of the greatest value for ordinary manufacturing purposes. Likewise the gases of coke ovens can be utilized in the same way, adding greatly to the importance of the gas engine in its new field.

Bituminous Macadam Pavement.

In a paper read by Mr. C. A. Kenyon at the convention of the Indiana Engineering Society, the name bituminous macadam was selected by the inventor for a pavement of broken stone mixed with bituminous cement. It combines the good qualities of macadam with the best qualities of the asphalt pavement. It eliminates the bad qualities of the asphalt as well as the bad features of macadam, and yet it is a stone pavement. Every engineer knows that a very good pavement can be built of broken stone without any cementing material. The course angular pieces of stone, when submitted to heavy pressure, fit and wedge themselves together in such a way that the resultant mass will bear great loads. The mass thus laid, will have with 3-inch stone, from 40 to 45 per cent. of voids. These voids while not uniform in size, will be large compared with the voids in ½-inch stone.

Rains and water ravel and wash macadam badly, so that tons of the road metal go into the sewers or are washed away by each storm. Water goes through it and softens the foundation, and it loses its grade. The fine metal on the surface mixes into a pasty mud. In dry weather that mud becomes dust, high winds blow it off the road, and it must be

replaced at great cost. Such a pavement must be sprinkled. It is costly to clean because the economical sweeping machine cannot be used and so it must be cleaned by hand. It is costly to maintain.

Mr. Frederick J. Warren sought experimentally to discover a pavement which would combine the best qualities of macadam and sheet asphalt. He took a cubic foot of solid stone fitted a box over it, weighed the stone, and then broke it into pieces about 2 inches in diameter, attempted to replace all the stone in the box, and but little more than ½ in volume or weight would go back into the box. He undertook the task of so breaking and arranging the sizes of that remaining out of the box, that he could place it all back into the box. While he did not put all of it back in the box, he did put 90 per cent. of it back, and discovered and formulated the principle whereby, with predetermined proportions, he can accomplish practically the same results every time. After discovering a way to reduce the voids in a mixture of stone to 10 per cent., the work was not finished. In order to accomplish a useful result, it was necessary to find a way to get that compact mass of stone into a pavement surface, and keep it there. It was finally decided that a bituminous cement of great uniformity and durability in all temperatures, one that should be absolutely unaffected by water, and one with great cementing strength, was necessary. The result was the Puritan brands of bituminous cements. Of course this had to be followed by the devising of appropriate bins, screens, mixers, heaters and machinery for the manufacture and laying of the pavement.

The pavement is constructed with from 4 to 6 inches of 2½ inch to 3-inch crushed hard stone foundation, laid on a thoroughly compacted subgrade. This foundation is thoroughly compacted by a 15-ton road roller and brought to a true surface. Hot bituminous cement is then poured over the surface so that it will run into the interstices, thus binding it together and making it waterproof. Many engineers favor this form of foundation in preference to hydraulic cement concrete, which is pervious to water, and has not the advantage of having been wedged into place by the use of a heavy roller. The concrete foundation for any pavement is of recent origin ; the first one used in London was in 1872. On top of this foundation is placed the wearing surface. The broken stone is heated in revolving drums, to about 200° F., and then, by carefully arranged screens, sorted into sizes and deposited into separate bins. From each of these bins, can be drawn the exact amount of the particular size required, the aggregate of which corresponds to the result of the experiments, and when compressed into a mass, approaches to 90 per cent. of a solid stone. This aggregate is then put into a revolving mechanical miner and the heated bituminous cement, by exact weight, poured in and the mixing continued until every piece of stone from the largest to the finest powder is covered with a thin waterproof coating of the bituminous cement. It is then dumped into a wagon, hauled to, and deposited in a layer on the foundation prepared as above described, and then rolled with a 15 ton road roller.

The result is practically a solid. It is rigid because the large, angular stones in the mass are wedged together. These large stones thus wedged would bear the weight of any load likely to be hauled over them, without the use of cementing material. It is therefore not necessary, as it is in the construction of an asphalt pavement, which is sand mixed with bituminous cement to have the cement so stiff or hard that under all atmospheric conditions the cement is strong enough to hold the grains of sand in a column. The sand without the cement, no matter how arranged, will not bear any load.

The advantages claimed for this kind of pavement may be summed up as follows ; The smaller materials fill the voids in the larger materials, thus giving great density ; the bituminous cement makes the pavement absolutely waterproof ; the bituminous cement holds the fine material in the interstices, preventing it from shifting or going to the bottom as in the ordinary macadam, and also preventing the pavement from rolling into waves ; the cement forms a cushion between the stones and prevents them from rubbing against one another, thus making the pavement elastic and quiet ; in such a dense and rigid mixture, the exposure of the cementing material is reduced to a minimum, permitting the use of a softer bituminous cement, which will retain its cementing property much longer in this form of pavement, than cements will in the asphalt or sand mixtures, giving great durability to the pavement ; being waterproof, homogeneous, and dense, rain and water cannot wash, or wind blow, any part of it away ; it can be flushed with water for cleaning, or swept with a sweeping machine ; since the surface is slightly indented by the laying of the stones, a flush coat of quick drying cement is poured on or squeezed into these indentations, and fine sand and screenings are spread over the surface and rolled in with the heavy roller, by which means, while the pavement has a surface for the wheels equal to asphalt it provides a foothold for horses equal to macadam.

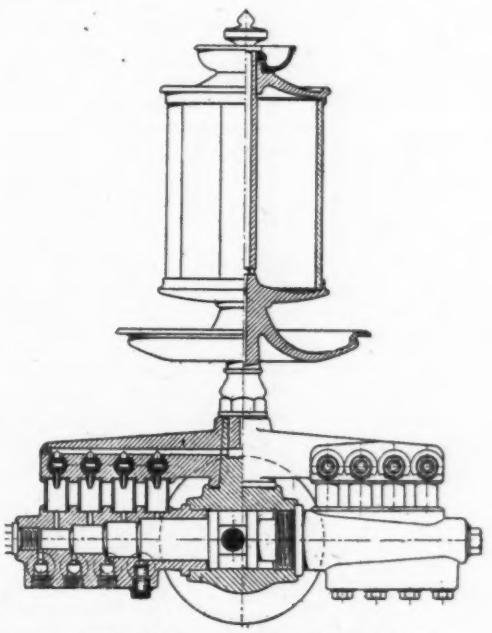
The question of cost is difficult to answer without knowing the conditions, cost of stone, labor, size of contract, etc. It is not advocated as a cheap pavement, but on account of its great excellence. Last year there was laid and contracted for, in over forty cities from Boston to Seattle, over 640,000 square yards of bituminous macadam pavement.

An Unusual Design of Oil Pump.

Engineering News notes that European steam engines are, as is well known, quite generally fitted with central oiling systems, in which a central reservoir with pump or gravity supply feeds oil to the various bearings by separate pipes. Sometimes such oiling systems are arranged for pressure supply, to give more efficient lubrication to heavily loaded bearings. A novelty in central oiling systems, which we note in a large steam engine recently built in Germany, is the use of separate pumps for supplying the several oil pipes. The pumps are combined in a single mechanism in a rather interesting manner.

The engine which this pump supplies is a vertical compound engine of 400-horse power. It has three separate oiling systems: (1) The shaft bearings, the crank pins and the eccentrics are oiled by a lubricator mounted on the cap of each shaft bearing, which supplies that bearing directly and the adjacent crank pin and eccentric by oil pipes. (2) The shaft governor and the attached high pressure admission eccentrics are oiled by a lubricator mounted on the governor casing. (3) The cylinders, the stuffing boxes, the crosshead guides and the crosshead pins are supplied through oil pipes fed by a pump. The first two of these oiling systems show nothing unusual; the third is interesting, as already mentioned, by reason of the use of a multiple pump which gives an independent oil supply for each oiling point. Since the high and the low pressure sides require to be separately oiled, the pump must supply oil to eight different points.

A longitudinal section through the cylinders of the pump is shown in the accompanying drawing. There are eight cylinders, having a



Eight Cylinder Oil Pumps for Steam Engine Lubrication.

common axis, and arranged symmetrically to two sides of a central point. The diameters of the cylinders in the series of four on each side decrease away from the center. There is a single piston formed in steps, so as to make a plunger piston for each cylinder; this multiple piston is reciprocated by a crank actuated by the high pressure exhaust eccentric. Above the battery of cylinders is mounted a supply reservoir, and from here the oil flows into a distributing duct which is separately connected to the inlet ports of the eight cylinders. Between each cylinder and this distributing duct, is a sight feed glass and a cock, so that the supply can be adjusted to suit the requirements of the particular point lubricated by that cylinder. The delivery ports, on the lower side of the cylinders, are provided with spring check valves to prevent a return of oil from the delivery pipes. It will be evident from the drawing that while the pump does not give a forced supply in case of

free delivery of the oil, anything which tends to hinder the flow of the oil in any of the pipes will cause the pump to produce a corresponding pressure in that pipe. This is utilized in the case of the crosshead in a neat manner: The oil pipe for oiling the guides runs up through the standards and ends in an opening on the face of the guide. The crosshead shoe is made long enough to always cover this opening, and thus the oil is forced out between the guides and the shoe and is distributed by grooves on the face of the shoe. The oil supply is intended to be sufficient in amount and pressure to float the shoe on a film of oil and thus give minimum friction. The oil pipe for the crosshead pin, which also runs up through the standard, has an opening on the face of the guide opposite a vertical groove in the shoe: from this groove an oil passage runs to the bearing of the pin, which thus also has a pressure supply. Suitable oil guards below the crosshead catch the waste oil and return it to an oil drain.

The oil pump described above is manufactured by Schaeffer & Budenberg, of Magdeburg, Germany. The engine to which it was fitted in the present instance was a Lentz engine, built by Meer Bros., of München-Gladbach, Germany. The engine is described in the *Zeitschrift des Vereins Deutscher Ingenieure*, to whom we are indebted for the cut which we reproduce.

The Mechanical Accountant.[1]

The keeping of correct accounts is an important factor in the success of an engineering business. Unfortunately, it involves very considerable expense, much of which can never be fruitful. To the enthusiastic accountant such a statement sounds like heresy, but nevertheless it is true. Really complete accounts—that is, such accounts as will furnish an answer on demand to any questions the manager can put—are like the *Encyelopædia Britannica*, they contain vast stores of information that are not consulted by their owners once a year or once a decade—possibly never at all. Under these conditions it is seldom that books are kept really completely. Even if they are laid out on a comprehensive plan, they are apt to get into arrears, and often their scope will be deliberately curtailed as time goes on. When certain classes of facts have been tabulated for months—possibly for years—without any use being made of them, it is natural that a doubt should arise as to their practical value, and that, when economies are being sought, they should be abandoned. Even if the head of the counting house is an enthusiast, and resists all temptations to slackness and retrenchment, it often happens that his efforts are pronounced failures by the manager. If the latter wishes to trace some circumstance, such as declining profits, to its source, he may have to wait long for an answer to a simple question, for it will involve the taking out of an immense number of figures from daily and weekly sheets, and their reduction to some common denomination before they can be compared. Often when the material has been collected it will be found that some important factor is missing, and that a complete answer cannot be given. But even if that be not so, the delay is always irritating. The clerical staff of a werks is of a size to meet the usual requirements, and only a small portion of it can be detached for inquiries of a special nature. Hence it is seldom possible to get information of an unusual kind except at considerable intervals, when possibly the need for it has passed. Consequently the attempt is seldom made.

Facts are like soldiers—they are no use until they are marshalled. A general with a mob of a hundred thousand men can do nothing; he cannot get them into line or square, except by actually pushing each man into place. He can give no effective orders, because the words of command are not understood. Manœuvres, evolutions, and combined movements are impossible, since it would take hours or days to get the men into formation. The manager of a works is usually almost as helpless in the face of the costs accounts. It is true that he has some officers to put his ideas into execution, but their numbers are inadequate to the multitude of facts, each one of which has to be put into its place in each combination as if it were the clumsiest recruit fresh from the plough. Certain simple formations, giving the costs of each job, the total wages per week, and the like are practised week by week, and offer no difficulty; but when these are exceeded, the labor of effecting a new arrangement becomes very great.

Facts are said to be stubborn things, but the imputation does not extend to the records of facts. They are passive enough, and display no volition at all. That is the trouble with them; they can never be taught, as is the soldier, to group themselves in desired order, and it requires endless effort to move them into different formations. It is as if one had to arrange the pieces in a kaleidoscope to form the various patterns; the delight in the changes would be lost in the labor of attaining them. It would not be worth going through so much to get so little. But if one has only to turn the instrument to effect the change from one gorgeous grouping to another, then the case is different. Just so with figures; if by turning a handle they can be made to arrange themselves in such a way that their significance becomes clear, and if they can be made to line up in groups, and if their relations between themselves can be revealed to the eye as in a diagram, then they become of real value, and the tale they have to tell is worth more than it costs. Immediately, the mob of recorded facts becomes a highly drilled army, trooping off obediently at word of command, and capable of assuming a serious of different formations in a short time. Fortunately, this is no fancy picture ; figures can be dealt with by machinery, and the meaning can be extracted from them with great rapidity. Quite recently we have explained how this was done in the United States Census by a machine based on the principle of the Jacquard apparatus. The basis of the system is a card with a number of holes punched in it, each hole having a definite meaning, representing a number, a locality, a color, a crop, or whatever else is desired. The superstructure of the system is an electric tabulating machine cabable of taking note of every hole a card does, or can, present, of selecting and grouping the cards according to the presence or absence of certain holes, of computing the totals represented by any sets of holes, and, in a word, of extracting all the information the cards supply, and of arranging it in a hundred different ways.

It is quite unnecessary to labor the description of the machine to make it clear to the intelligent mechanic. Once the idea is set forth, many of the possibilities of the apparatus spring into view of themselves. For instance, let us assume there are ten classes of men in a works—erectors, fitters, planers, drillers, slotters, etc.—and that across the width of the card there are ten places which can be punched, each corresponding to one class of men. Evidently a great heap of such cards could be fed, automatically or by hand, through a machine which would sort them out into classes, or into groups of classes, at will, and would indicate the numbers in each class. Further, if the earnings per hour and per day, and the number of hours worked in the day were indicated by other punchings, these could be totalled at the same time. Any one of these items might be made the basis of classification instead of the occupation of the men. For instance, the machine might be set to divide the men into groups, according (1) to the number of hours worked per week; (2) according to their wages per hour; or (3) according to their total earnings. The number of the job on which a man was engaged would naturally be indicated by one or more punchings, and the passage of the cards through the machine might effect the separation of all the cards relating to one job. At the same time the machine would total the men of the various classes, the number of hours worked, the wages paid, and the like. By passing the set of cards through again it might be divided afresh into groups representing different kinds of labor working on the job, and the cost of each would be shown separately.

Let us suppose that in a works a 100-horse power engine has been turned out, and that the accounts show it has cost less than a similar engine constructed three years ego. The manager wants to discover the cause of the economy. It may be due to new tools bought in the interval, to a lower average of wages paid, to a speeding up of the tools, or to better methods and discipline by which the output of the men is increased, or to a combination of two or more of these causes. To get this information from the books would be an onerous business, and would need the personal attention of some one of marked ability. But when the data are punched on cards, the job can be put in the hands of a girl. The passage through the machine of all the daily cards belonging to the periods during which the jobs were in the shops would pick out all the cards pertaining to the engines, the other cards being replaced in their proper order. Then it would be easy to dissect the accounts, and find the number of men of each class on the job, the number of hours worked, the average and total wages for each class of men, and the whole, the amount charged for shop expenses to each type of machine, and so on. All these comparative figures can be obtained by simply passing the cards one or more times through the machine, and making small adjustments between the passes, so as to alter the basis of comparison.

The machines that are made for such purpose by the Tabulating Machine Company, Washington, D.C., U.S.A., use cards 5⅝ inch by 3¼ inch. All the cards of a given day's work are punched in the first three rows, as follows: First, a hole to indicate the year; next, a hole to indicate the month, then a hole to indicate the week of the month, and, finally, a hole to indicate the day of the week. Then come a series of

1. *Engineering.*

noles to record (1) the number of the operative, (2) the number of the job, (3) whether the job was done by day labor, piece work, or was related to shop expenses, (4) the lot number, (5) the number of the part of the machine on which the man worked, and (6) the total number of hours and quarter hours consumed. Further, other holes set forth the rate of wages per hour, the total wages, and the sum to be added for shop expenses. Of course, these data can be altered or amplified to suit special conditions of work or the requirements of the place. In a system in which all the data are inscribed in writing, and all the calculation is done on paper, it is foolish to pile up facts and figures, because it is certain they will never be used. The labor is too great. But if after the cards are punched all the rest is machine work, the case is quite different. The punching itself can be done admirably by girls, and, indeed, all the operations are peculiarly suited for female execution.

It is not worth while to attempt a detailed description of the machines by which the punching and tabulation are effected. The mechanical mind will readily grasp their general principles, while the exact construction would need drawings for its explanation. Suffice it to say that there are two forms of punches. One, the gang punch, which will punch several holes at once, and a key punch, with a keyboard comparable to a typewriter, by which any hole can be punched at will. The tabulating machine is actuated electrically. When a card is put into it, a large number of needles or feelers are advanced, and those which find holes opposite to them pass through the card and complete an electric circuit. The current thus set up can operate counting or sorting mechanism. Evidently several needles may be arranged in series, so that the circuit is not complete unless they all find holes in the card opposite to them. For instance, if it were known that on one day last year a certain man was working on a particular job, and it was desired to fix that particular date, the machine could be set to throw out the card or cards containing the punchings corresponding to the man's number and the number of the job, and no other. Of course, the success of such a machine must depend largely on its speed of working. When cards accumulate at the rate of 500 a day, their number soon reaches alarming figures, and unless they can be dealt with very rapidly, the system loses its chief advantage. There seems no reason, however, why the cost of the machine should be so great as to prevent the use of several in a large works. It is no more complicated than a Jacquard loom.

Rates and Methods of Charging.

[A paper read by MR. J. W. SHUSTER, at the Milwaukee meeting of the Northwestern Electrical Association.]

It will be conceded that a current basiness policy is the first requisite for progress in any business undertaking.

The success of any company in the electric lighting business, and the confidence placed in it by its consumers, are dependent to a very large extent upon the adoption of a fair and equitable method of charging.

That station managers are coming to recognize this fact is shown by the varied, interesting and instructive discussions which have recently taken place in the different Lighting Associations, and particularly in the National Electric Light Association.

Most questions of great importance have numerous theories proposed as their correct solution. In this respect the question of charges is no exception.

I will endeavor to present a few of the more promising methods of charging which are being adopted in this country.

In the outline which follows, the several systems are scheduled with the particular point of service which they are designed to cover.

Methods.

1. Flat rate.—Contract price on 16-candle power lamp per month.
2. Meter rate.—a. Charge per kw. hour. b. Discount or sliding scale depending on total power consumed.
3. Wright maximum demand.—a. Charge on maximum demand of capacity for first two hours per day. b. Charge on basis of cost of generating per kw. hour for power used subsequently.
4. Doherty rate.—a. Fixed charge—office expenses, reading meters, etc. b. Stand-by charge—Interest, depreciation, taxes and insurance. c. Power charge—Cost of generating per kw. hour.
5. Fore-See system.—a. Stand-by charge on sliding scale. b. Power charge.
6. Double rate meter.—Different rate per kw. hour depending on the time of day.

Taking the systems in the order named, I will endeavor to bring out the distinguishing feature of each. The only apology for mentioning the flat rate in this discussion is the fact of its existence. It came into use as the first method of charging before meters were developed and before the station man had gone into details as to methods of charging. One feature of this method which makes it popular with consumers is that the charges are a fixed amount per month, and the customer knows just what he will be called upon to pay. The fact that the station has no check on the length of time the lamps are in use, or the power delivered, makes it obvious that the rate is unjust and entirely void of business principles. Therefore, the rate should be refused entirely, or what is equivalent, it should be made so high that all consumers will prefer some meter rate.

The progress of the question of rates is the ordinary development from the crude to the more refined. The natural step from the flat rate to the introduction of a meter which would record the power used by a consumer, and then make a charge per unit of power consumed. This condition was approximated when the ampere hour meter was introduced and a charge made per ampere hour. This instrument did not take into account the variation in line voltage, and was soon displaced by the recording wattmeter, which is now almost universally adopted for measuring the power delivered. The charge was then made on the kw. hour basis.

On the face this seems a very adequate method of charging, for in the majority of business undertakings, if the seller is paid for the commodity delivered, the transaction is satisfactory. While in dealing with most commodities a charge for the product delivered is an equitable one, the supplying of electric power involves conditions which are seldom or never met with in other lines of business. These conditions require the working out of special systems of charging which are more equitable to both station management and consumer, and which are reasonably applicable to all cases.

The most important of these special conditions is the fact that no adequate method of storing electrical energy economically is in existence. This necessitates the keeping in readiness at all times the apparatus of the station, such as dynamos, engines, boilers, transformers, etc., which are loaded to their full capacity for only a short interval each day during the busy part of the year, and are never fully loaded during the season of light loads. To keep in readiness this large installation requires a corresponding investment, on which a reasonable return for interest, depreciation, tax and insurance must be obtained before any profit can accrue. Now if a consumer uses his power for only a short period of time each day, and that at the time of heaviest load, or during the peak, it means that the station management must purchase and maintain all the apparatus necessary to supply this consumer and depend on him for returns on the same. If it does not do this, it must serve him at a loss and overcharge the long hour consumer to make up the deficit.

On the straight meter rate, with the present limitations, it is practically impossible to charge the short hour consumer a sufficiently high rate per kw. hour to cover the expense to which he puts the company.

To devise a system by which each consumer pays his proportionate part of the stand-by charges has been the purpose of a number of leading station men in this and other countries. Mr. Arthur Wright, of Brighton, England, was one of the first to attack the problem of capacity charge in a systematic manner. He introduced what is known as the Wright Maximum Demand System in Brighton in 1893.

Mr. Wright determined from his station costs that the stand-by charge was the main item of expense. He devised an instrument by which he could determine accurately the maximum capacity of the station used by any customer. He also determined the cost of generating per kw. hour after all stand-by charges were paid. From these stand-by expenses and the cost of generating power he determined the income which he must have from each kw. of plant installed if used for two hours per day throughout the year. Then for power used in excess of two hours per day he charged at a rate per kw. hour determined from the cost of generating. The ratio between these two rates he found to be 4.4; then if the first rate was 20 cents per kw. hour, the power subsequently used would be furnished at 4.5 cents.

Mr. Wright invented a very serviceable instrument known as the Wright Maximum Demand Meter. This meter records the maximum current used by a consumer during the interval between two readings. This meter is read at the same time as the recording watt-meter, and from its indication the amount of station capacity used by this consumer, and the amount of power to be charged at the high rate are determined. All power in excess of this is charged at the lower rate. For example, if the demand meter reads 10 amperes on a 100-volt circuit, and the recording watt-meter registers 90 kw. hours, and the maximum charge is made on two hours per day, the first charge will be on $10 \times 100 \times 2 \times 30 \div 1{,}000 = 60$ kw. hours. Taking the rates at 20 cents and 4½ cents respectively, the bill will be $(60 \times \$.20) + \$.045 = \$12.045$.

This system gets at the correct basis of charging, but has a weakness in that the very short hour consumer will not use power enough to pay for the demand or stand-by charge even at the higher rate. Taking the case above; if the watt-meter reading is 30 kw. hours, the total bill will be 30 × $0.20 = $6.00, or only half the amount determined on as the stand-by power charge. So that the system fails to reach the very class at which it is aiming.

This defect in the system is obviated in some cases by making the high rate charge a fixed charge and collecting it whether the power is consumed or not. Beside this, the management in many cities are limited by franchise so that 8 or 10 cents per kw. hour is the maximum charge which can be made. Obviously the Wright Demand system would be of little benefit in such cases.

The leaders in the rate reform in the United States have attacked the problem of determining equitable rates in much the same way as it was taken up by Mr. Wright. However, instead of making the capacity charge payable on a kw. hour rate on the first 2 hours' use of the installation per day, it is made a fixed charge per lamp and the total amount of this fixed charge is determined by the number of lamps which the customer demands at any one time. His service is then limited by an interrupter or similar device which winks the lights when the predetermined demand is exceeded. While an interruption of the circuit in this way may be objectionable in some cases, it has the advantage that it can be checked by the consumer, and there can be no suspicion on his part that the meter reader is beating him.

When a consumer has settled his demand and paid or fixed his demand charge, he is charged for the power consumed on the basis of generating costs which obviously gives him a low kw. hour rate and he will for this reason use his lights more freely and thus broaden the peak of the load and greatly improve the load factor. One station which has used this system for a little more than a year reports an increase of 50 per cent. in the output of the station for the year, with an increase in the cost of coal of 20 per cent.

This method of charging has been advocated quite thoroughly before the National Electric Light Association, particularly by Mr. H. L. Doherty, Past President of this Association, in 1900, and in a modified form, called the Fore-See system, by Mr. Wallace in 1901.

The apparent equity of the capacity charge system and the hearty discussion and approval which it has received from leading central station men point to its general adoption, and a study of the methods of determining this charge is of considerable interest. Differences of opinion are encountered as to what should be included in the stand-by or capacity charge. Mr. Doherty takes the general office expenses and makes this a fixed charge per customer, while Mr. Wallace includes this in the stand-by charge. The first is the more logical, since the capacity charge is on stand-by losses and is calculated as a definite per cent. on the cost of the station per kw. on the assumption that it is not being used. Evidently the office expense is not a factor in this case. It has the disadvantage, however, of making the divisions of the charge too numerous to suit the consumer who does not understand the method by which they are determined.

While it is desirable to make a capacity charge sufficient to insure the plant from a loss on short hour consumers, this charge should be made as small as possible, so that the lamps demanded will be a large per cent. of the total lamps connected.

The items which unquestionably come into this charge are interest, taxes and insurance. Depreciation is usually figured in on this charge, but in my opinion only so much of this item as is due to apparatus going out of date should be included. Depreciation due to wear and tear should go to generating expenses.

Numerous other items, such as coal for banking fires, etc., are sometimes included in the capacity charge; but when there is a question as to where a charge should go, I would put it in the generating costs and make the actual output pay expenses just as far as possible, and not impose on the special privilege granted on account of special conditions.

The distribution of the loads of different consumers as to time makes the maximum demand on the station much smaller than the sum of the demands of the individual consumers. On the meter basis of charging it has been found that the maximum load on the station is usually from one-third to one-half of the total lamps connected. Under the new method the lamps demanded will be considerably less than the total lamps connected, and experience with the system is required before one can determine with a reasonable degree of accuracy the maximum load which is likely to come on the station. This once determined, the stand-by charges per lamp demanded should be equally distributed.

If we take interest at 5 per cent., depreciation (as above stated), taxes and insurance 7 per cent., we have from the following table the stand-by charges per kw. installed per year on stations which cost from $100 to $400 per kw., and in columns 5, 6 and 7, the annual charge per lamp figuring that the ratio of station capacity to lamps demanded is 1 to 1, 1 to 2, and 1 to 3, respectively:

1	2	3	4	5	6	7
Total Cost of Station Per kw.	Interest. Per Cent.	Depreciation, Taxes and Insurance. Per Cent.	Annual Stand-by Charge Per kw.	Annual Stand-by Charge Per Lamp. Rtio 1 to 1.	Annual Stand-by Charge Per Lamp. Ratio 1 to 2.	Annual Stand-by Charge Per Lamp. Ratio 1 to 3.
$100	5	7	$12	$ .60	$ .30	$ .20
200	5	7	24	1.20	.60	.40
300	5	7	36	1.80	.90	.60
400	5	7	48	2.40	1.20	.80

This charge and the office charge make a definite fixed charge by contract corresponding to the flat rate. The power consumed is then charged for by the kw. hour at a rate based on the cost of generating.

This method charges the expense of readiness to serve equitably among consumers and relieves the plant from the chance of loss on the short hour consumer.

The low rate per kw. hour delivered will have a strong tendency to broaden the peak and increase the output of the station.

The double rate meter developed by the General Electric Company is a recording watt-meter with a clock movement by which the driving mechanism is shifted from one dial to another at a predetermined hour. The object of this system is to give a low rate to customers using power during that part of the day when the station is not loaded. While this method would have a strong tendency to broaden the peak, it would also tend to reduce the maximum, which should not be done. Obviously the high rate will come at an hour in the evening, especially in the business district, when light is very essential, and if the rate is doubled or tripled at that time, as it is by companies using this system, it will mean a reduction of lighting of business places or the adoption of a light other than electric, either of which is undesirable from the station standpoint.

While the amount of power used, the time of its use, the location of the consumer, etc., make an absolutely equitable charge difficult to obtain, the systems which are being adopted approximate this to a reasonable degree, and with the experience of a few years of actual use we may expect the details to be worked out to a refinement which will greatly improve the business conditions of central stations and give the consumer the fairest treatment possible.

ITEMS OF INTEREST FROM VARIOUS LOCALITIES.

MR. JULIUS KIMBALL, who was largely instrumental in the original forming of the Racine (Wis.) Gas Light Company, and of the Kenosha (Wis.) Gas Company, died at his home in Kenosha the morning of the 26th ult. Deceased was born in Montreal, Canada, October 29, 1818, and in 1837 became a resident of Kenosha. His name is identified closely with the material advancement of Kenosha and Southport, and as they thrived so did he. He was a man of liberal ideas and practice, and many will miss him for the quiet charity that he so freely and ungrudgingly bestowed. If we mistake not, a son (Mr. R. N. Kimball) is Superintendent of the Kenosha Gas and Electric Company.

THE following from the Philadelphia *Press* of the 1st inst., respecting a special meeting of the Directors of the United Gas Improvement Company, explains itself: "The special meeting of the Board of Directors of the United Gas Improvement Company held to-day was called to consider the annual estimates of requirements for construction and betterment and enlargement of the different plants controlled by the Company. It has been the custom of the Company to provide a portion of the funds for such purposes by giving the stockholders an opportunity to subscribe to new issues of stock at par; this custom will be continued, and at the proper time the usual legal notice will be given notifying the stockholders that the matter of an increase in the capital stock will be submitted to them for action at the annual meeting on the first Monday in May. The increase that will be asked for will be 36 per cent. of the present issued stock, or 169,500 shares of the par value of $50 each, aggregating $8,475,000."

AT the annual meeting of the Granville (N. Y.) Gas Company the following officers were elected: President, B. G. Hiley; Vice-President, W. J. Gallagher; Secretary and Treasurer, N. T. Drake.

AT the annual meeting of the St. Paul (Minn.) Gas Light Company the following officers were elected: Directors, Emerson McMillin, Kenneth Clark, A. P. Lathrop, Crawford Livingston, M. Auerbach, E. A. Young and George H. Prince—Mr. Prince succeeds Mr. F. W. M. Cutcheon; President, A. P. Lathrop (he is also General Manager); Vice-President, Kenneth Clark; Secretary and Treasurer, J. P. Crowley.

REPRESENTATIVE LESLIE YATES, of Philadelphia, has introduced a bill in the Pennsylvania Legislature that provides for the payment by

the companies of the State that manufacture gas of an annual tax of 5 mills on the actual value of their capital stock.

MR. MARTIN MALONEY, of Philadelphia, has secured control of the property and franchises of the Lakewood (N. J.) Gas Company.

THE Directors of the New Bedford (Mass.) Gas and Edison Light Company have declared a dividend of $4 per year.

THE corporate name of the Baraboo (Wis.) Gas and Electric Light Company has been changed to that of the Baraboo Lighting Company.

MR. WALTON FORSTALL, Assistant Engineer of Distribution, Philadelphia Works of the U. G. I. Company, writing to the JOURNAL, says: "It is our custom to send to every house where we have occasion to do work, a reply postal card to be used in notifying us if the job is not satisfactory. The inclosure herewith is a copy of a reply received the other day on one of these postals. I send it as throwing some light on the character of our service and as a testimonial to the poetic ability of the Philadelphia gas consumer."

THE inclosure mentioned by Mr. Forstall is appended:

"The man was here,
The old meter's gone;
The new one works
Just like a charm.
It gives us light
Enough to read,
And cooks our meals
So we can feed.
"It heats the water
Into a boil,
Housework's a pleasure,
Less half its toil.
"Your foreman did
His work so well,
Our trouble's over
For quite a spell;
"But if we're bothered
At any time
I'll send that foreman
A hasty line."

"A. B. B.," WRITING to us from Philadelphia, under date of the 3d inst., incloses the following: "The Frederick (Md.) Gas Company was organized at Frederick last Friday. It is capitalized in $150,000, and its Directors are: State Senator Jacob Rorhback, Chas. Wertheimer, and Edwin C. Markell, of Frederick; Francis K. Carey and Richard C. Congdon, of Baltimore; Albert B. Beadle and Charles L. Serrill, of Philadelphia. The Directors elected officers as follows: Jacob Rorhback, President; Albert B. Beadle, Vice-President and General Manager; Chas. L. Serrill, Secretary and Treasurer; Richard C. Congdon, Resident Manager. The Company recently purchased the Isabella Gas Works, which they will reconstruct and enlarge sufficiently to supply the demand for illuminating and fuel gas. When the weather permits a number of larger mains will be laid through the principal street of Frederick, and also in the new sections. The officers of the Company state they will expend over $25,000 this spring in laying mains and properly equipping the plant."

AT the annual meeting of the Delaware (O.) Gas Company the officers chosen were: Directors, V. T. Hills, J. W. Hills, T. C. Jones, Archibald Cybrand and F. P. Hills; President, V. T. Hills; Vice-President, J. W. Hills; Secretary and Superintendent, T. C. Jones.

MR. GEORGE H. STACK of the Utica (N. Y.) Gas and Electric Company has been offered, and likely will accept, the position of Superintendent of the Albany and Hudson Railway Company.

AT the annual meeting of the Cambridge (Mass.) Gas Light Company no change was made in the executive management. The shareholders consented to a motion to petition the Board of Gas and Electric Light Commissioners for the right to increase the capital stock by the issuing of 5,800 shares.

"S.," WRITING from New Britain, Conn., under date of the 2d inst., says: "The following may be of interest to the readers of the JOURNAL. At the last meeting of the Board of Directors of the New Britain Gas Light Company, the resignation of Mr. E. C. Learned, who for 33 years had been the Superintendent of the Company, was accepted. Mr. Learned has had his resignation under consideration for the past 2 years, and now felt that action must be taken so that he might enjoy a vacation from business cares. Mr. H. M. Belle, Mr. Learned's assistant, was promoted to the place of Superintendent."

AT the annual meeting of the Portland (Me.) Gas Light Company the officers chosen were: Directors, E. H. Daveis, Wm. H. Moulton, F. N. Dow, Elias Thomas, Chas. S. Fobes and Geo. F. Kavanough; President, E. H. Daveis; Vice-President, Wm. H. Moulton; Treasurer and Clerk, Burton Smart. The yearly report of the President showed that the make, for the twelvemonth amounted to 81,902,000 cubic feet, and that the unaccounted-for gas did not exceed 4 per cent. of the output. The report of the Company's Engineer (Mr. E. H. Yorke) showed that the gain in meters for the last 8 months of the year was 574. An excellent business was also done in the placing of arc and incandescent gas lamps (84 of the former and 1,041 of the latter); and 144 gas ranges were put in service.

LAST month a feature of the proceedings of the Junior Department of the Young Men's Christian Association, of Oakland, Cal., was the delivering of a lecture on the subject of "Gas," by Mr. John A. Britton, President of the Oakland Gas, Light and Heat Company. The lecturer made liberal application of chalk on a blackboard the better to illustrate his subject, and some of the older listeners asserted that teaching was in reality the lecturer's true vocation.

THE price of gas in Chester, Pa., has been advanced to $1.25 per 1,000 cubic feet, from $1. The increased rate, which dates from the 1st inst., will only prevail during the continued abnormal prices of coal and coke.

MR. R. C. BOEKKLEN, known to the fraternity as the inventor of the Boekklen process of gas making, died at his home, No. 536 Eleventh street, Brooklyn, Sunday, the 1st inst. He was in his 77th year.

MR. WM. J. WHITING, a member of the firm of Messrs. S. F. Hayward & Co., of this city, died at the Seney Hospital, Brooklyn, N. Y., the morning of the 1st inst. He had been operated upon for appendicitis. The funeral services were held in 208 Hewes street, Brooklyn, E.D., the evening of the 3d inst.

AT the annual meeting of the Dover (Del.) Gas Company the officers chosen were: H. A. Richardson, Du Pont Walker, Wm. Saulsbury, A. B. Richardson and W. S. Wilson; President, H. A. Richardson, Secretary and Treasurer, Du Pont Walker.

THE proprietors of the Consolidated Gas Company, of Baltimore, Md., are considering the advisability of concentrating their manufacturing plants at a central station. That move should have been made at least 10 years ago.

A CORRESPONDENT incloses the following: "The Coldwater (Mich.) Gas Light and Fuel Company has fully shared in the general prosperity that prevailed throughout the country, and the past year has exceeded all others in its history for increase of gas manufactured and general business done. Over 14,500,000 cubic feet of gas were produced this past year, an increase over the same period of last year of 1,500,000 cubic feet. Plans have already been made to take care of this enlarged business, and a contract for a gasholder with a capacity of 50,000 cubic feet has already been let and work thereon will begin in the spring as soon as the frost is out of the ground. The cost of building and completing this holder will be $12,000. At the annual meeting the officers chosen were: Directors, B. H. Calkins, F. W. Moore, G. C. Turner, H. C. Loveridge, L. E. Rose, L. M. Wing and A. S. Upson; President, B. H. Calkins; Vice-President, H. C. Loveridge; Treasurer, F. W. Moore; Secretary, Geo. C. Turner.

THE Philadelphia *Ledger*, of recent date, is our authority for this bit of news: "The high price of coal is given in explanation of the quarterly statement of the United Gas Improvement Company, which shows that 539,604,520 more cubic feet of gas were used during the quarter ending December 31, 1902, than during the corresponding period in the previous year. The statement was rendered to the City Controller Jan. 26th, and shows that during the quarter ending December 31, 1902, there was 1,795,064,370 cubic feet of gas sold, as compared with 1,225,460,850 cubic feet for the corresponding quarter of last year. During this quarter $1,527,923.34 was collected by the Company, as compared with $1,091,108.90 for the quarter of last year, an increase of nearly half a million dollars. The city's share, amounting to about 10 per cent. of the total collections, is $152,792.33 for the quarter just ended, for payment of which sum a check has been made out to the order of the City Treasurer."

THE AMERICAN GAS LIGHT JOURNAL

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Notification Respecting Advertising.—Orders for new advertising, or for changes in standing advertisements, to insure attention in the issue following their reception, must be in hand any time of Wednesday.

AGENTS:

New York—American News Co. 39 and 41 Chambers St.
Germany—Lemcke & Buechner, of New York.
England—Aug. Siegle, 30 Lime Street, London.

MONDAY, FEBRUARY 9, 1903

The Market for Gas Securities.

The market for city gas shares was a trifle more than steady during the week, with a net gain in Consolidated since last time of writing of a point. It closed to-day (Friday) at 217 to 217¼. At the Directors' meeting for organization of the Consolidated Company some important rearrangements in the executive staff were made. Several changes are reported, but the most important, at least so far as the fraternity in this section are concerned, was the naming of Mr. W. R. Addicks, of Boston, Mass., to the position of First Vice-President. It is an excellent appointment, no matter why it was made, and we know that he will do the Company and himself credit. There is some demand for Mutual, and there is a good demand for city gas bonds.

Brooklyn Union gas is quiet, and the Company is making some important contracts in connection with its manufacturing divisions, which, to an outsider, would be taken that the amalgamation of interests with the Consolidated was not close at hand. However, some sorts of apparatus can be moved. Peoples, of Chicago, soars, and Baltimore remains steady.

Gas Stocks.

Quotations by George W. Close, Broker and Dealer in Gas Stocks.

16 WALL STREET, NEW YORK CITY.
FEBRUARY 9.

☞All communications will receive particular attention.

☞The following quotations are based on the par value of $100 per share.

N. Y. City Companies.	*Capital.*	*Par.*	*Bid.*	*Asked.*
Consolidated	$73,177,000	100	217	217¾
Central Union, Bonds, 5's.	3,000,000	1,000	110	112
Equitable Bonds, 6's	1,000,000	1,000	105	..
" 1st Con. 5's	2,300,000	1,000	118	120
Metropolitan Bonds	658,000	..	108	112
Mutual	3,500,000	100	310	325
Municipal Bonds	750,000	..	..	..
New Amsterdam Gas Co. ..				
Bonds, 5's	11,000,000	1,000	112⅛	113
Northern Union, Bonds, 5's.	1,250,000	1,000	108	110
New York and East River ..				
Bonds 1st 5's	3,500,000	1,000	112	113
" 1st Con. 5's	1,500,000	..	109	111
Standard	5,000,000	100	131	..
Preferred	5,000,000	100	132	..
Bonds, 1st Mortgage, 5's	1,500,000	1,000	115½	118
Yonkers	299,650	500	130	..
Out-of-Town Companies.				
Brooklyn Union	15,000,000	100	220	226
" " Bonds (5's)	15,000,000	1,000	119	119½
Bay State	50,000,000	50	¾	1
" Income Bonds	2,000,000	1,000	..	75
Binghamton Gas Works	450,000	100	28	30
" 1st Mtg. 5's	509,000	1,000	93	96
Boston United Gas Co.—				
1st Series S. F. Trust	7,000,000	1,000	82	85
2d " " "	3,000,000	1,000	47½	50
Buffalo City Gas Co.	5,500,000	100	7½	10
" " Bonds, 5's	5,256,000	1,000	75	77
Capital, Sacramento	500,000	50	..	35
Bonds (6's)	150,000	1,000	..	..
Central San Francisco	900,000	..	106	108
Chicago Gas Co. Guaranteed Gold Bonds	7,650,000	1,000	104	104¼
Cincinnati Gas & Elec. Co.	29,500,000	100	99⅞	100
Columbus (O.) Gas Co., 1st Mortgage Bonds	1,500,000	1,000	101	101½
Columbus (O.) Gas Lt. & Heating Co	1,682,750	100	88¼	89½
Preferred	3,026,500	100	107½	109
Consumers, Jersey City Bonds	600,000	1,000	103	106
Consumers, Toronto	1,700,000	50	218	225
Consolidated, Baltimore	11,000,000	100	70½	71
Mortgage, 6's	3,600,000	..	..	118
Chesapeake, 1st 6's	1,000,000	..	..	..
Equitable, 1st 6's	910,000	..	..	..
Consolidated, 1st 5's	1,490 000	..	..	112
Consolidated Gas Co. of N.J.	1,000,000	100	15	17
" Con. Mtg. 5's	380,000	1,000	85	87
Consolidated G. & E. Co.'s. Little Falls, N.Y.	90,000	100	..	100
Bonds	75,000	..	..	100
Detroit City Gas Co	4,825,500	50	..	89
" Prior Lien 5's	5,603,000	1,000	99½	100
Detroit Gas Co., 5's	381,000	1,000	77	79
" Inc. 5's	16,000	100	94	94½
Equitable Gas & Fuel Co., Chicago, Bonds	2,000,000	1,000	..	101
Essex and Hudson Gas Co.	6,500,000	..	34	38
Fort Wayne	2,000,000	..	..	..
" Bonds	2,000,000	..	55	..
Grand Rapids Gas Lt. Co. 1st Mtg. 5's	1,225,000	1,000	104½	105
Hartford	750,000	25	245	265
Hudson County Gas Co., of New Jersey	10,500,000	..	25	..
" Bonds, 5's	10,500,000	..	101	103
Indianapolis	2,000,000	..	..	68½
" Bonds, 6's	2,650,000	..	102	105
Jackson Gas Co	250,000	50	73	75
" 1st Mtg. 5's	290,000	1,000	101	102½
Kansas City Gas Light Co., of Missouri	5,000,000	100	..	36
Bonds, 1st 5's	3,822,000	1,000	102	104
Laclede, St. Louis	10,000,000	100	80	85
Preferred	2,500,000	100	95	100
Bonds	10,000,000	1,000	109½	110
Lafayette Gas Co., Ind.	1,000,000	100		60
Bonds	1,000,000	1,000	60	65
Louisville	2,570,000	50	112	120
Madison Gas & Elec. Co.				
" 1st Mtg. 6's	350,000	1,000	107½	108½
" 6 per cent. scrip, due 1910	100,000	25	85	87
Montreal, Canada	2,000,000	100	218	184¾
Newark, N. J., Con. Gas Co	6,000,000	..	56	58
Bonds, 6's	4,600,000	..	105	105¾
New Haven	1,000,000	25	300	325
Nashville Gas Lt. Co.	1,000,000	100	110	..
Oakland, Cal.	2,000,000	..	46	47
" Bonds	750,000	..	..	..
Peoples G. L. & Coke Co., of Chicago	25,000,000	100	107¼	107⅛
Peoples Gas Lt. & Coke Co., Chicago, 1st Mortgage	20,100,000	1,000	..	..
2d "	2,500,000	1,000	104	
Rochester Gas & Elec. Co.	2,150,000	50	88	..
Preferred	2,150,000	50	118	..
Consolidated 5's	2,000,000	..	87½	90
San Francisco, Cal.	10,000,000	100	41½	42½
St. Paul Gas Light Co.	1,500,000	100	45	47
1st Mortgage 6's	650,000	1,000	113	116
Extension, 6's	800,000	1,000	112½	115
General Mortgage, 5's	2,465,000	1,000	92	93
St. Joseph Gas Co.				
" 1st Mtg. 5's	751,000	1,000	95	96½
Syracuse, N. Y.	1,975,000	100	29	..
Bonds	2,047,000	1,000	99½	100
Washington, D. C	2,500,000	20	410	415
First mortgage 6's	600,000	..	..	..
Western, Milwaukee, Bonds, 5's	4,000,000	..	109½	110
Wilmington, Del.	600,000	50	232	..

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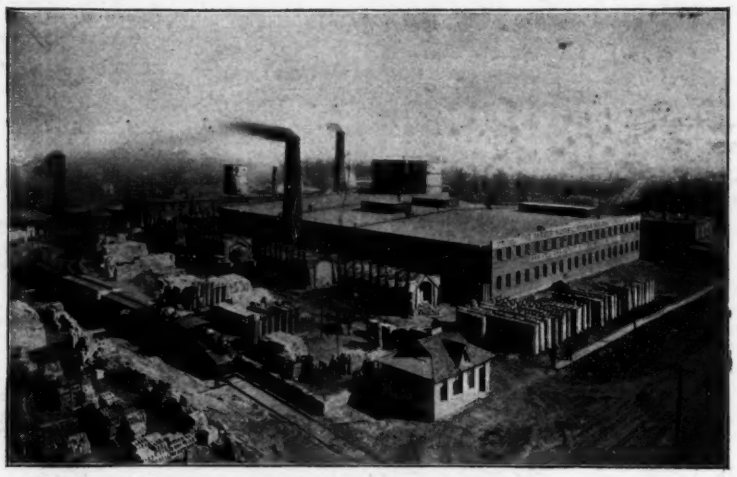

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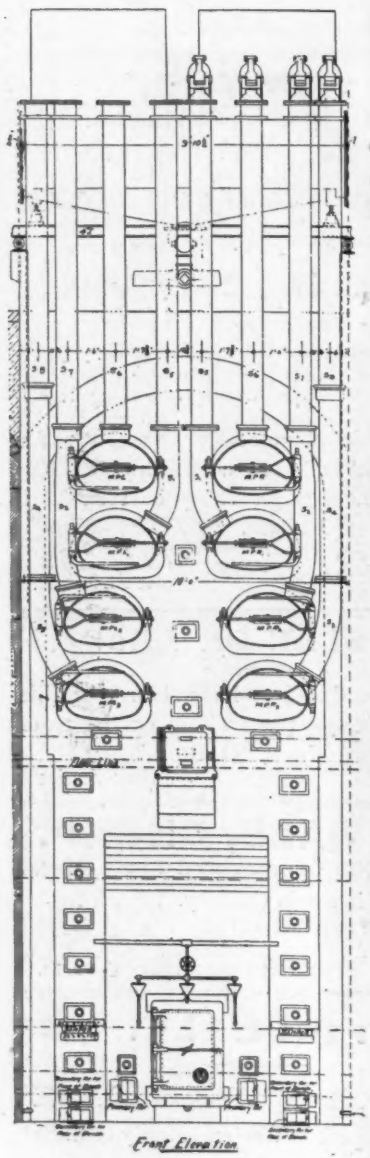

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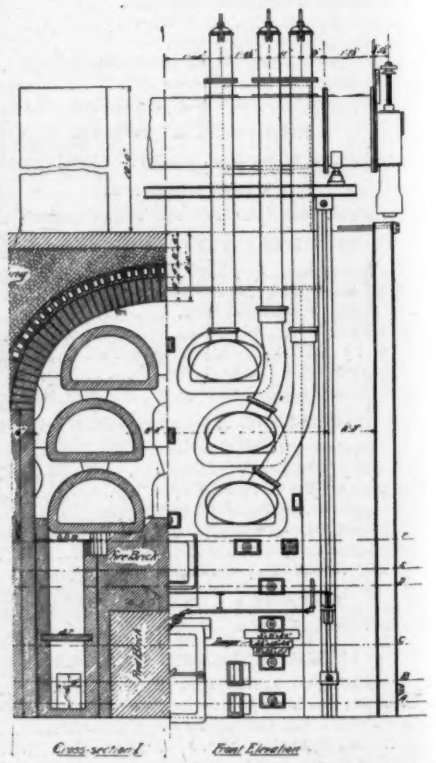

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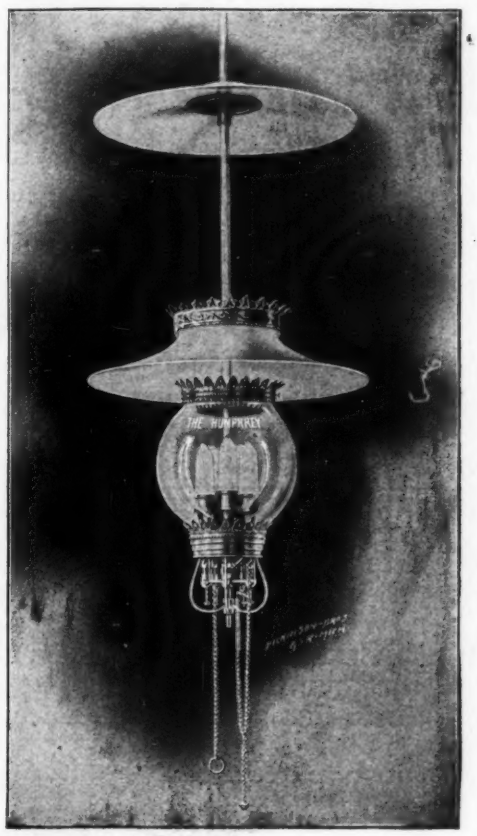

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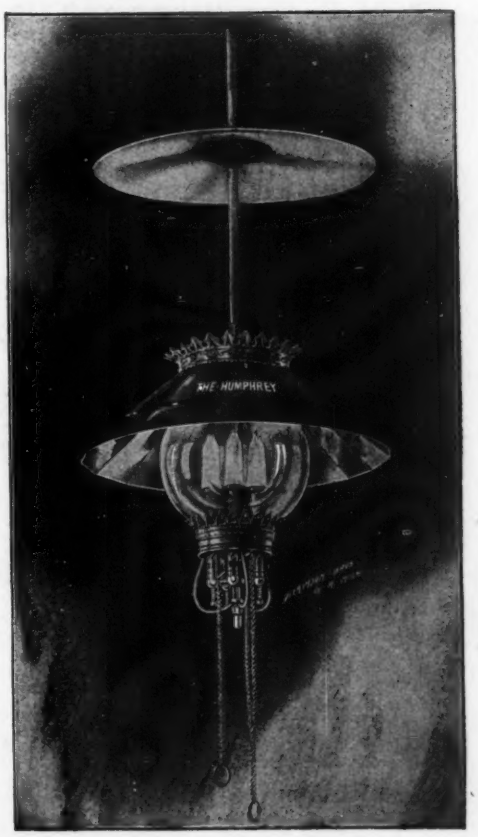

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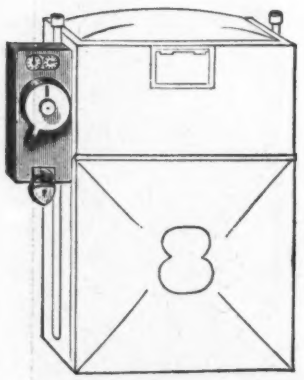

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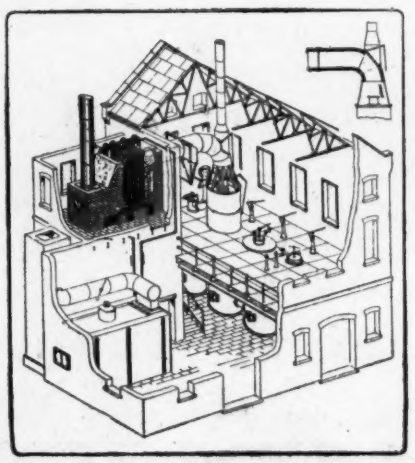

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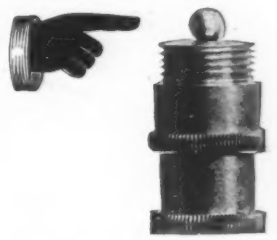

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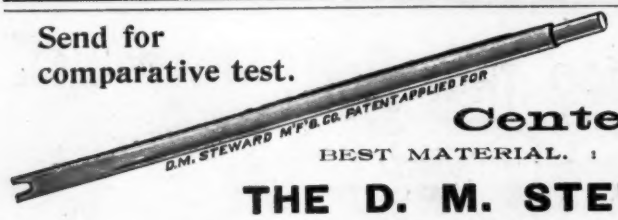

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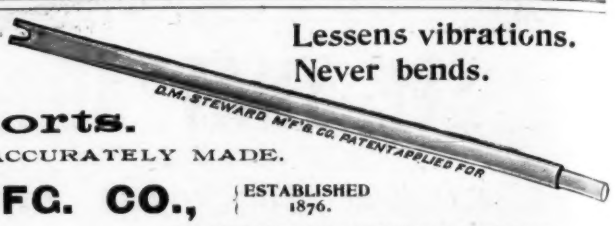

Lessens vibrations. Never bends.

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3

Gas Analyses of All Sorts and Conditions,
—OR—
Analyses of Solid and Liquid Materials as Well,

That are needed by Gas Companies at any time in the conduct of their business, may be obtained from

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AUTOMATIC SCALES
Send for Catalogue.
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Utilize Your Gas Liquor.
NO EXTRA LABOR OR OPERATING EXPENSES.
Ammonia Concentrator.
Not Expensive. Write to
STROH & OSIUS, Pat'ees, or
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ELECTRIC GAS LIGHTING.

How to install electric gas igniting apparatus, including the jump spark and multiple systems for use in houses, churches, theaters, halls, schools, stores or any large building. Also, the care and selection of suitable batteries, wiring and repairs.

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Price, 50 cents. Orders may be sent to
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Gas properties,
Electric light properties.
Street railway properties.
Also desirable franchises.

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To burn a given amount at a stated pressure, made to order. Samples furnished. Also, small oil and air valves, slow-feed valves for high pressure, and small brasswork in general.

Drip Pumps, Service Cleaners, Gasfitters' Proving Pumps and Mercury Gauges.

C. GEFRORER & SON,
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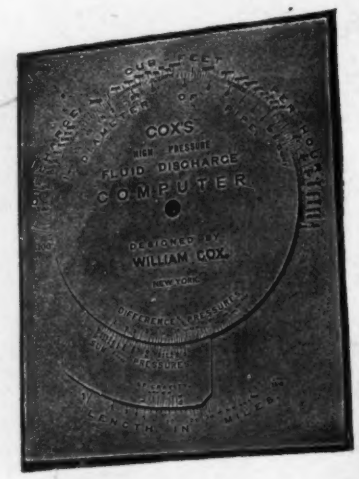

COX'S HIGH-PRESSURE FLUID DISCHARGE COMPUTER.

This Computer solves the following formula, which is applicable to Gas, Air and other elastic fluids, flowing through long pipes with high initial pressures:

$$\text{Discharge in cubic feet per hour at atmospheric pressure} = 33.3\sqrt{\frac{d^5 \times (p_1^2 - p_2^2)}{L \times w}}$$

Where d = diameter of pipe in inches,
p_1 = absolute initial pressure in pounds per square inch,
p_2 = absolute terminal pressure in pounds per square inch,
L = length of pipe in miles,
w = specific gravity of the fluid when air = 1.

To Find the Discharge from a Pipe and the Required Size of Pipe.

(1.) Set the specific gravity of the fluid opposite the length of pipe;
(2.) Bring the DIFFERENCE of the initial and terminal gauge pressures opposite the SUM of the initial and terminal gauge pressures;
(3.) Opposite any diameter of pipe will now be found the discharge in cubic feet per hour at atmospheric pressure; and
(4.) Opposite any desired discharge will also be found the required diameter of pipe.

Price of the Computers, in Cloth Case, 6½ x 8 inches, $5 Each, Net.

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THIRD AND ENLARGED EDITION.

BY

GEORGE LUNGE, PH.D.

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PRACTICAL HANDBOOK ON GAS ENGINES, WITH INSTRUCTIONS FOR CARE AND WORKING OF THE SAME,

By G. LIECKFELD, C.E. Translated with Permission of the Author, by GEO. M. RICHMOND, M.E. Price, $1.00.

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BRAY BURNERS

Of Uniform Excellence and Greatest Candle Power.

BEWARE OF IMITATIONS.

WILLIAM M. CRANE CO.,

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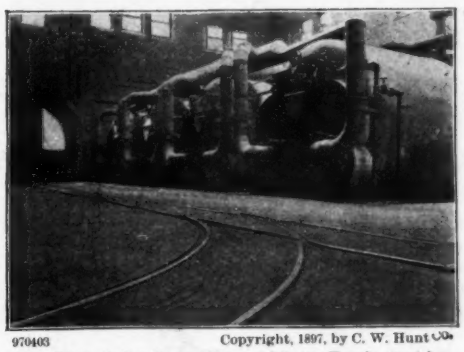
SOLE AGENTS FOR UNITED STATES.

Have you seen Bray's new "LUTA" burner for acetylene gas?

GAS WORKS BOILER ROOM TRACKS AND FLOORS.



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Cast Plate Boiler Room Floor, with Car Tracks Cast in.

We furnish cast plate railway track in sections 5 feet long and 27 inches wide. For the remaining space, cast iron floor plates, 13 inches square, make an excellent and durable floor, pleasing to the eye, cleanly, with a good foothold for the firemen, and an almost entire absence of wear or repairs. These plates do not chip, crumble or crack, and their use reduces fire risk. They do not loosen from expansion caused by drawing the fires out. It is without any exception whatever the best and most durable boiler or engine floor in use.

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THE C. W. HUNT COMPANY,

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PITTSBURG OFFICE: 515 Penn Avenue.

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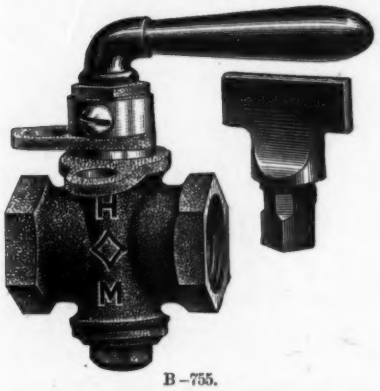
Mueller Gas Cocks.



B-755.

TOO little is not as much as you pay for, and too much is more paid for than you need.

In **Mueller Gas Cocks** you find a happy medium--not so little metal as to leave them weak, nor yet so much as to make them costly.

Made in 145 styles, seven sizes in each style.

MADE ONLY BY

H. MUELLER MFG. CO.,

DECATUR, ILLS., U. S. A.

THE

Ludlow Valve Mfg. Co.,

TROY, N. Y., U. S. A.

Double and Single Gate Valves, ¼" to 72",

—FOR—

Gas, Water, Steam, Oil, Ammonia, Etc.

HOT GAS VALVES A SPECIALTY.

Send for Catalogue.

"THE MINER"

Globe Street and Boulevard Lamps.

Cheapest and Best.

THOUSANDS IN USE WITH INCANDESCENT BURNERS.

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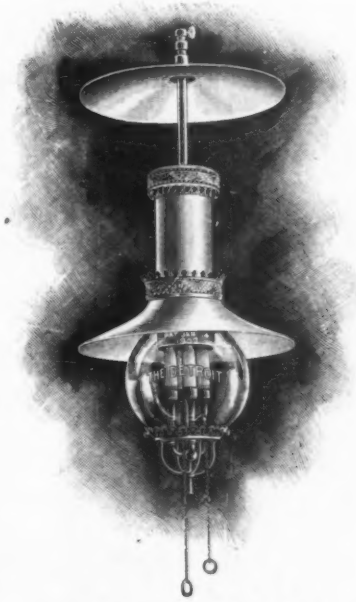
THOMAS T. W. MINER,

821-823 Eagle Av., N.Y.

The DETROIT



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ARC GAS LAMP.

Durability,
Efficiency,
Simplicity,
Economy.

Perfect Combustion.
No Chimneys to Break.
No Matches Necessary.
Consumes Less Gas.
A Handsome Fixture.
Always in Order.

Our lamp gives 25 per cent. ***more light*** with 20 per cent. ***less gas*** than any Arc Gas Lamp now on the market.

TO LIGHT CONSUMPTION WHAT THE GAS RANGE IS TO FUEL. : : : : :

SAMPLE ORDERS *Solicited.*

Manufactured by

The Detroit Arc Gas Light Co.,

67 to 71 Michigan Avenue,

DETROIT, MICH.

FRED. BREDEL, C.E.

Coal and Water Gas Plants.

OWN SYSTEM.

RECUPERATIVE FURNACES, WASHERS, CONDENSERS, PURIFIERS, PURIFYING MACHINES, COKE CONVEYERS, ETC.

SOLE UNITED STATES AGENT FOR

ARROL-FOULIS MECHANICAL CHARGING AND DRAWING MACHINES.

Gas Enriching Plants to Enrich Coal Gas up to 24 Candle Power, and Making a White, Bright, Non-smoking Gas.

GAS RETORTS AND SPECIAL BLOCKS AND FIREBRICK MANUFACTURED UNDER THE SUPERINTENDENCE OF MY OWN CHEMIST.

COMPLETE GAS WORKS

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MANUFACTURERS AND CONSTRUCTORS
OF GAS APPARATUS AND PLANTS.

OXIDE PURIFIERS,

With the Lloyd System of Valve Connections for Ordinary or Reverse Flow of the Gas.

THE ECONOMICAL GAS APPARATUS CONSTRUCTION COMPANY, LIMITED,

Engineers and Builders of water and coal gas apparatuses and general gas works machinery. : : :

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Drawings, Specifications and Estimates furnished for the construction of new works or alteration of old works. Special attention given to Patent Office drawings.

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Exhausters and Exhauster Governors.

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JONAS DRAKE & SON

SYSTEM OF

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ZIMMER SWINGING CONVEYORS,

FOR HANDLING COAL OR COKE.

Jones Jet Photometer.

GAS SPECIALTIES.

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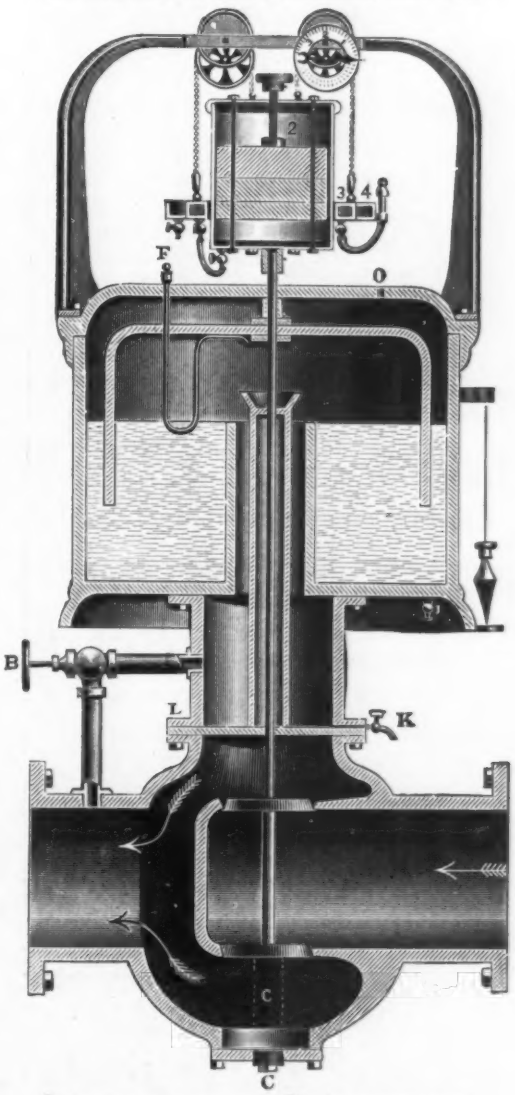

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MODEL OF 1900.

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"Globe" Specials, Valves, Etc. "Glamorgan" Pipe Fittings

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MANUFACTURERS OF

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Also, FLANGE PIPE, LAMP POSTS, Etc.

GAS TAPPING MACHINES

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Drilling and Tapping Pipe under Pressure

WITHOUT ANY ESCAPE OF GAS.

They are Strong and Compact.

Size of Combination Drills and Taps ¾ to 4-inch.

Machines Sent to any Gas Company for Thirty Days' Trial.

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Hughes' "GAS WORKS,"

Their Construction and Arrangement,

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Originally written by SAM'L HUGHES, C.E.
Rewritten and Much Enlarged by

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Eighth Edition, Revised, with Notices of Recent Improvements.

Price, $1.65.

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Valuation of Gas, Electricity and Water Works

FOR ASSESSMENT PURPOSES.

SECOND EDITION.

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With an Appendix of Decided Cases.

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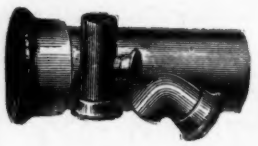

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CAST IRON WATER AND GAS PIPE,

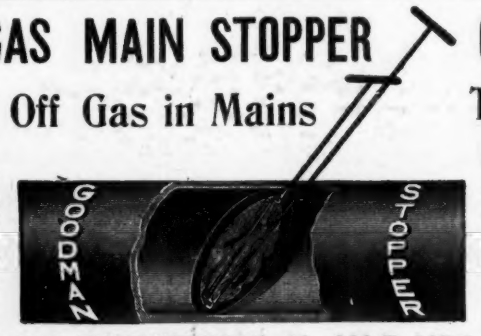
From Three to Forty-Eight Inches Diameter. Also, all Sizes of

Flange Pipe for Sugar House and Mine Work. Branches, Bends, Retorts, etc., etc.

SAFETY GAS MAIN STOPPER COMPANY,

For Shutting Off Gas in Mains

Any size gas main can be shut off in 30 seconds. : : :



Temporarily during alterations and repairs. : : : :

STOPPERS SENT ON TRIAL.

Address: SAFETY GAS MAIN STOPPER CO., 108 E. 117th St., New York City.

MOST GAS COMPANIES DO SELL, ~ ~ EVERY GAS COMPANY SHOULD SELL

Humphrey Crescent Instantaneous Water Heaters,

A LUXURY and NECESSITY.

This is Our No. 2 Heater.

Supplies hot water for domestic use as well as for the bath.

It Has No Equal

LIST PRICE NICKEL PLATED, $35.00,

including nickel plated shelf and brackets.

We have many styles, which range in price from our No. 10, at $45.00, to our No. 8, at only $20.00.

Every Heater Guaranteed.

SEND FOR CATALOGUE AND PRICES.

Will send heater on 60 days' trial to any Gas Company.

The Humphrey Manufacturing and Plating Company, KALAMAZOO, MICH., U. S. A.

Parson's Steam Blower

FOR IMPROVING BAD DRAUGHT IN BOILERS, AND FOR BURNING BREEZE OR OTHER WASTE MATERIAL.

PARSON'S TAR BURNER,

FOR USING COAL TAR AS FUEL.

PARSON'S AIR JET TUBE CLEANER,

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These devices are all first-class. They will be sent to any responsible party *for trial*. No sale unless satisfactory. Manufactured by the WATERTOWN STEAM BLOWER COMPANY.

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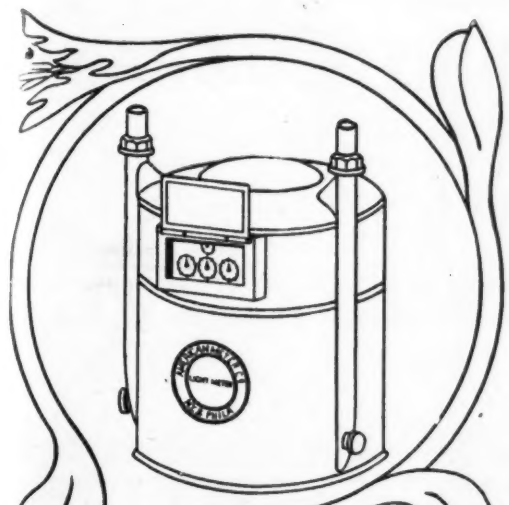

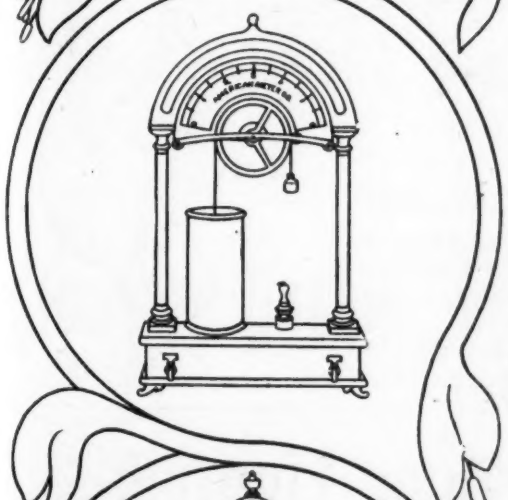

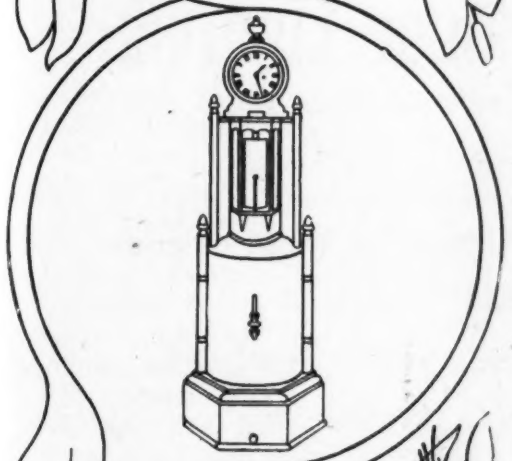

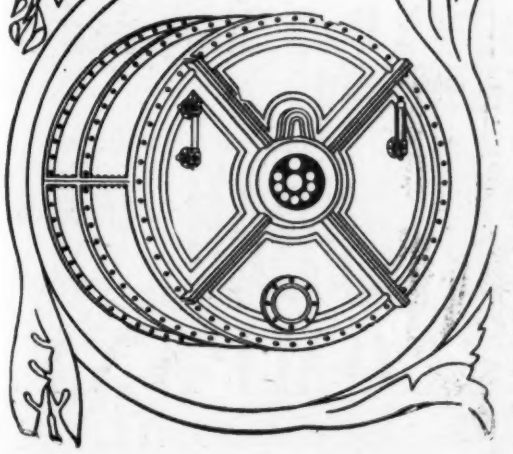

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AMERICAN METER CO.

ESTABLISHED 1834. INCORPORATED 1883.

NEW YORK
PHILADELPHIA,
CHICAGO,
ST. LOUIS,
SAN FRANCISCO.

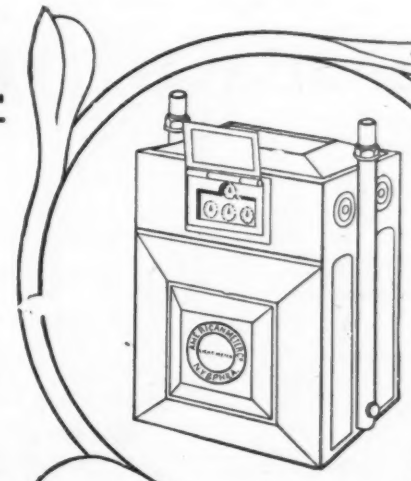
PUBLIC LIGHTING TABLE.

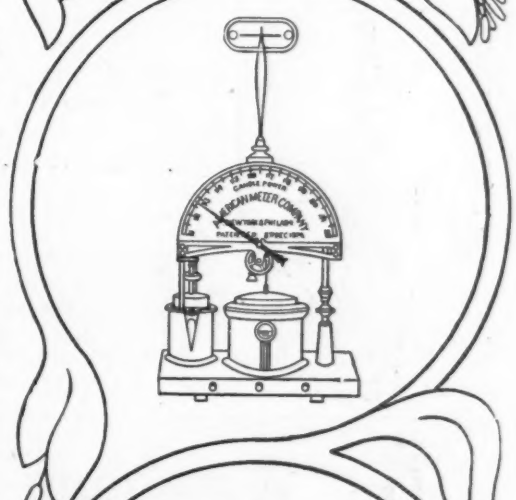
FEBRUARY, 1903.

Day of Week.	Table No. 1. Following the Moon. Date.	Light.	Extinguish.	Table No. 2. New York City. All Night Lighting. Light.	Extinguish.
				P.M.	A.M.
Sun.	1	5.50 PM	6.10 AM	5.05	6.15
Mon.	2	9.30	6.10	5.05	6.15
Tue.	3	10.30	6.10	5.05	6.15
Wed.	4	11.30 FQ	6.10	5.05	6.15
Thu.	5	12.40 AM	6.10	5.10	6.10
Fri.	6	1.40	6.10	5.10	6.10
Sat.	7	2.40	6.10	5.10	6.10
Sun.	8	3.40	6.00	5.10	6.10
Mon.	9	4.30	6.00	5.10	6.10
Tue.	10	No L.	No L.	5.10	6.10
Wed.	11	No L. FM	No L.	5.10	6.10
Thu.	12	No L.	No L.	5.20	5.55
Fri.	13	6.00 PM	8.50 PM	5.20	5.55
Sat.	14	6.00	9.50	5.20	5.55
Sun.	15	6.10	11.00	5.20	5.55
Mon.	16	6.10	12.00	5.20	5.55
Tue.	17	6.10	1.00 AM	5.20	5.55
Wed.	18	6.10 LQ	2.00	5.20	5.55
Thu.	19	6.10	2.50	5.30	5.55
Fri.	20	6.10	3.40	5.30	5.55
Sat.	21	6.10	4.30	5.30	5.55
Sun.	22	6.20	5.10	5.30	5.55
Mon.	23	6.20	5.40	5.30	5.55
Tue.	24	6.20	5.40	5.30	5.55
Wed.	25	6.20	5.40	5.30	5.55
Thu.	26	6.20 NM	5.40	5.30	5.45
Fri.	27	6.20	5.40	5.30	5.45
Sat.	28	6.20	5.40	5.30	5.45

TOTAL HOURS LIGHTING DURING 1903.

By Table No. 1.	Hrs. Min.	By Table No. 2.	Hrs. Min.
January	245.00	January	423.20
February	192.00	February	355.25
March	201.00	March	355.35
April	167.20	April	298.50
May	152.00	May	264.50
June	131.00	June	234.25
July	140.40	July	243.45
August	156.20	August	280.25
September	171.20	September	321.15
October	198.20	October	374.30
November	216.30	November	401.40
December	232.10	December	433.45
Total, yr.	2203.40	Total, yr.	3987.45

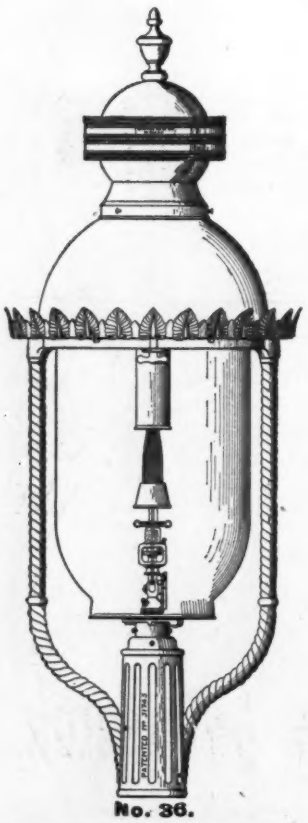




NEW YORK, 33 Nassau Street. PHILADELPHIA, Broad and Arch Streets. CHICAGO, Foot of Orleans Street. BOSTON, 624 Tremont Building.
CLEVELAND, 809 Cuyahoga Building. ST. LOUIS, 712 Roe Building. SAN FRANCISCO, 712 Polk Street.

WELSBACH STREET LIGHTING COMPANY

.... OF AMERICA ....


No. 36.

Controls and Operates the

Welsbach System of Street Lighting,

Which includes its specially DESIGNED AND PATENTED BURNER for STREET and PARK LIGHTING exclusively.

Uniformly SUCCESSFUL in 150 Cities and Towns.

By means of the Welsbach System of street lighting the superiority of GAS over electricity for street lighting has been fully demonstrated.

POINTS OF MERIT:

It is { Economical, Attractive, Successful, Up-to-date.

IT LIGHTS THE STREET.

Where there are no gas mains we can furnish an equally good light by our SELF-GENERATING NAPHTHA WELSBACH BURNER, and thereby supply a uniform light in all localities.

Correspondence Solicited from Gas Companies and Others Interested in Municipal and Outside Lighting.

No. 38.

The Welsbach Gas Arc for Indoor Lighting.

The cut tells the story—but not all of it. Get one lamp and light it—then the tale's told from beginning to end. For one Welsbach Gas Arc Lamp is a better salesman than 20 pages of advertising.

Here's what it would show if you give it a chance to prove its worth:

1. A mechanical construction and finish that insures the greatest durability.
2. The renewal of mantles and the cleaning of globes without removal of globe.
3. The greatest amount of candle power with least consumption of gas.
4. A by-pass cock so constructed as to permit all or only one mantle burning at a time.
5. A pilot light that consumes but 1 foot of gas in 24 hours. Costs $\frac{1}{10}$ of a cent a day.

Give it a Chance to Tell its Own Story and it Won't Disappoint.

Let us send you one lamp—doesn't cost a fortune—and it will answer every question you put to it; make good on every test given it. You know the only proof of the pudding? What's the use in a fellow telling you it tastes good? Taste it yourself, then you know.

May we Send you ONE Lamp?

WELSBACH COMPANY,

GLOUCESTER, N. J., and CHICAGO, ILL.

THE UNITED GAS IMPROVEMENT COMPANY

During the Year 1902 has been Awarded Contracts in the Following Places for

Standard Double-Superheater Lowe Water Gas Apparatus.

Atlantic City, N. J.	Flushing, N. Y.	Norristown, Pa.
Ardmore, Pa.	Hollidaysburg, Pa.	Norwalk, O.
Auburn, N. Y.	Houston, Tex.	Ocean City, N. J.
Belmar, N. J.	Indianapolis, Ind.	Oklahoma City, O. T.
Blue Island, Ills.	Jersey City, N. J.	Oneonta, N. Y.
Boonton, N. J.	Laconia, N. H.	Plainfield, N. J.
Brooklyn, N. Y.	Lakewood, N. J.	Portland, Me.
Carlisle, Pa.	La-Salle-Peru, Ills.	Pottsville, Pa.
Champaign, Ills.	Martinsville, Ind.	Scranton, Pa.
Coney Island, N. Y.	Memphis, Tenn.	South Brooklyn, N. Y.
Dallas, Tex.	Newark, N. J.	Suffern, N. Y.
Danville, Ills.	New Brunswick, N. J.	Swedesboro, N. J.
Des Moines, Ia.	New London, Conn.	Syracuse, N. Y.
Evanston, Ills.	New Orleans, La.	Washington, N. C.
Evansville, Ind.	Norfolk, Va.	Woonsocket, R. I.

TOTAL SETS, 1902, ... 51
TOTAL DAILY CAPACITY, 1902, . . 32,825,000 cubic feet.
TOTAL SETS TO DATE, ... 447
TOTAL DAILY CAPACITY, ... 299,670,000 cubic feet.

The United Gas Improvement Company,

Broad and Arch Streets, Philadelphia.

Established 1858. Incorporated 1890.
CHAS. E. GREGORY, Prest. DAVID R. DALY, V.-Prest. & Treas.
H. D. ABERNETHY, Sec.

J. H. Gautier & Co.

Greene & Essex Streets,
Jersey City, N. J.

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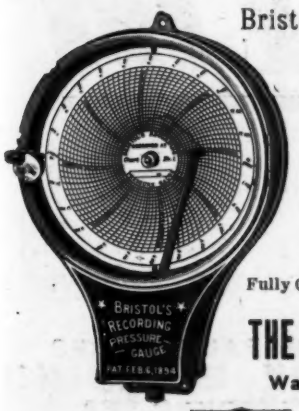

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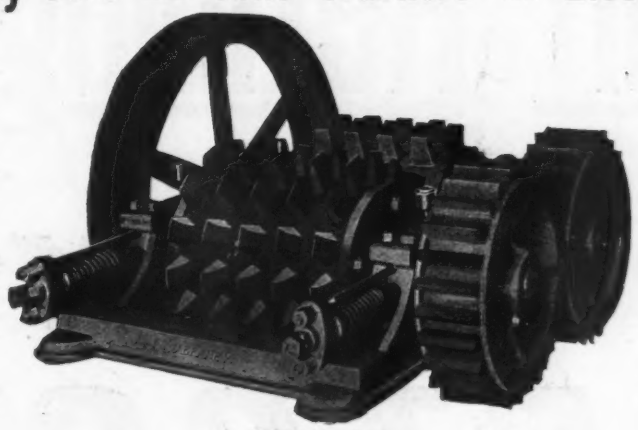

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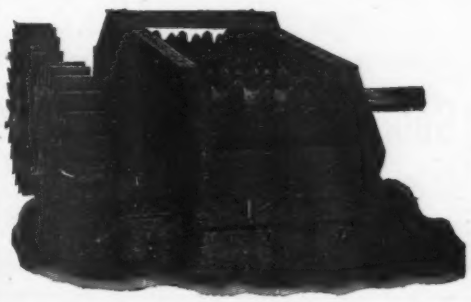

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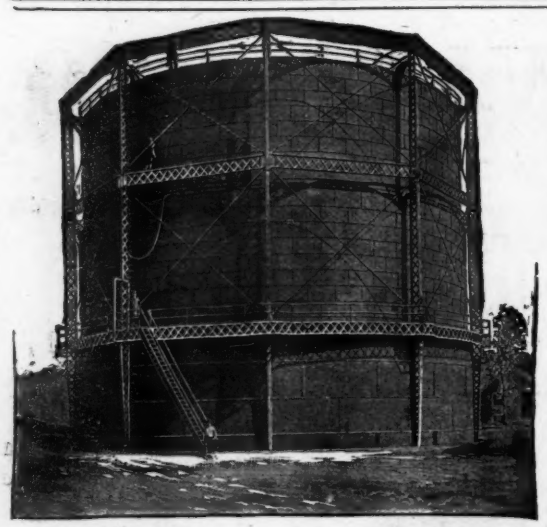

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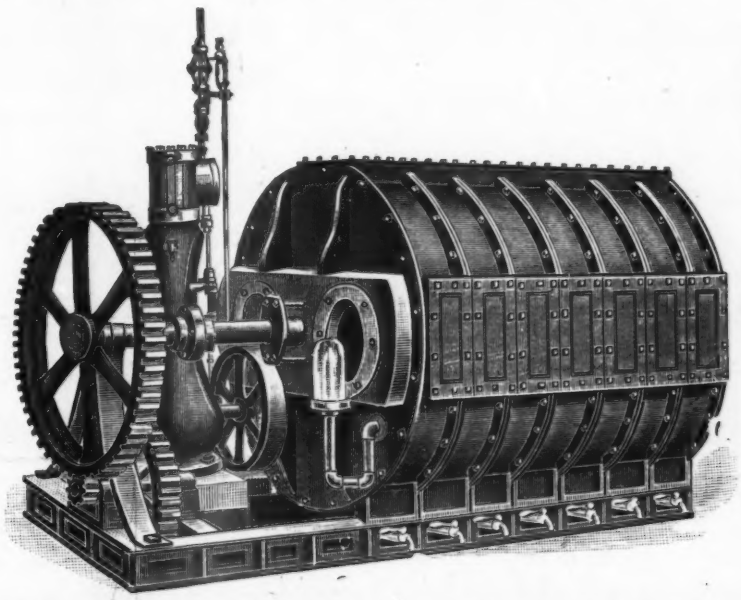

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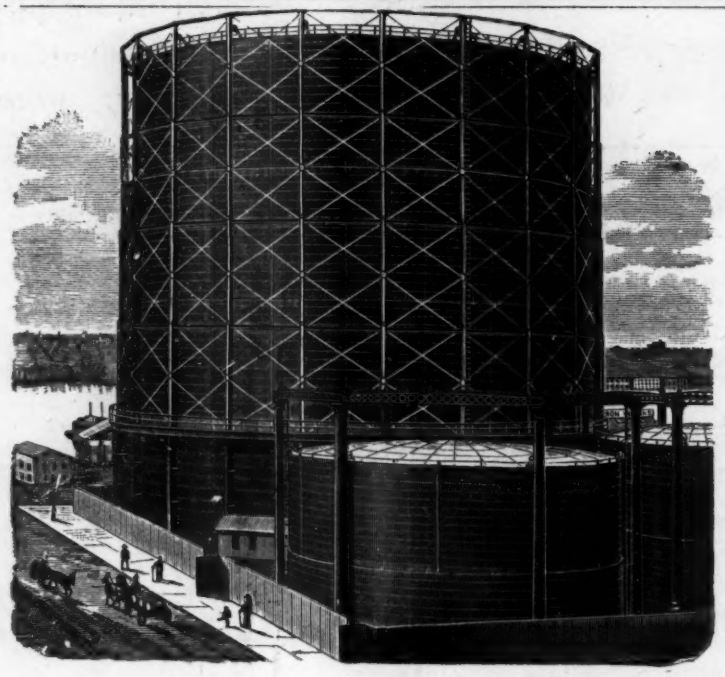

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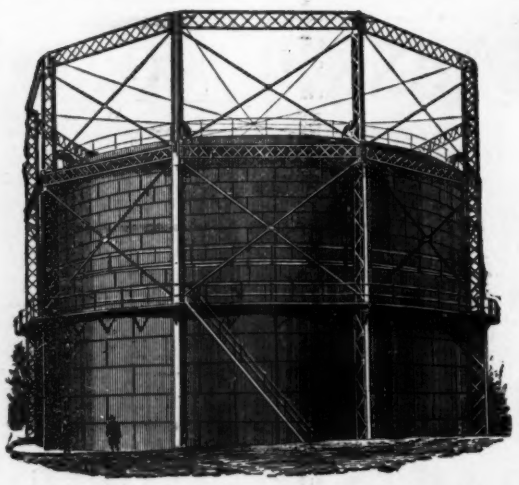

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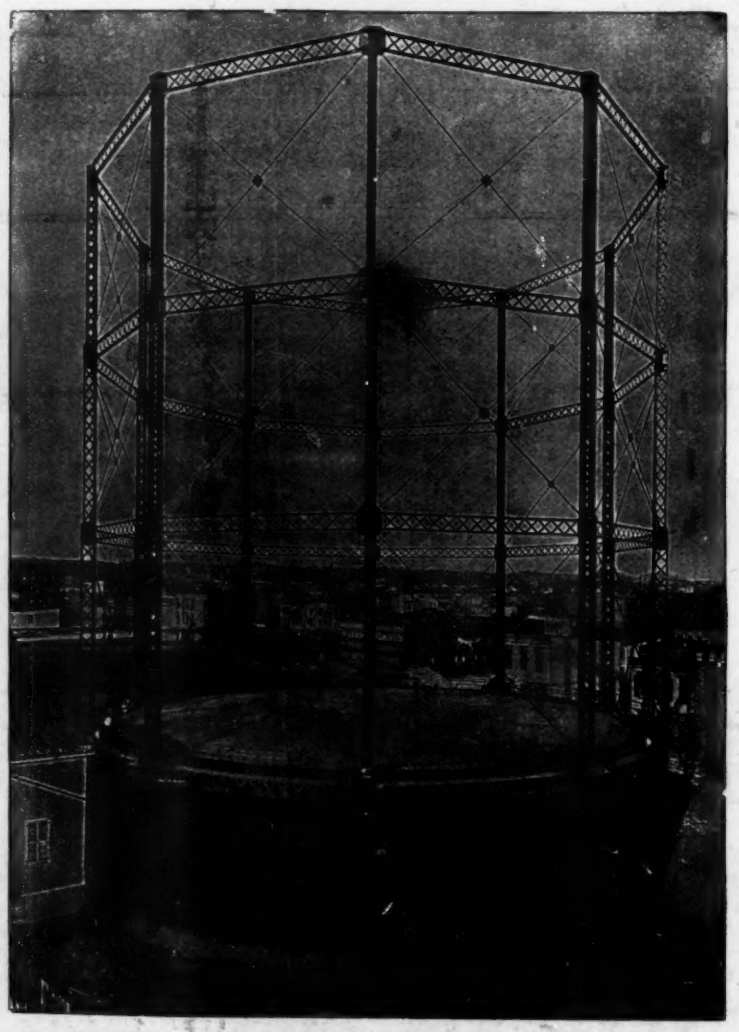

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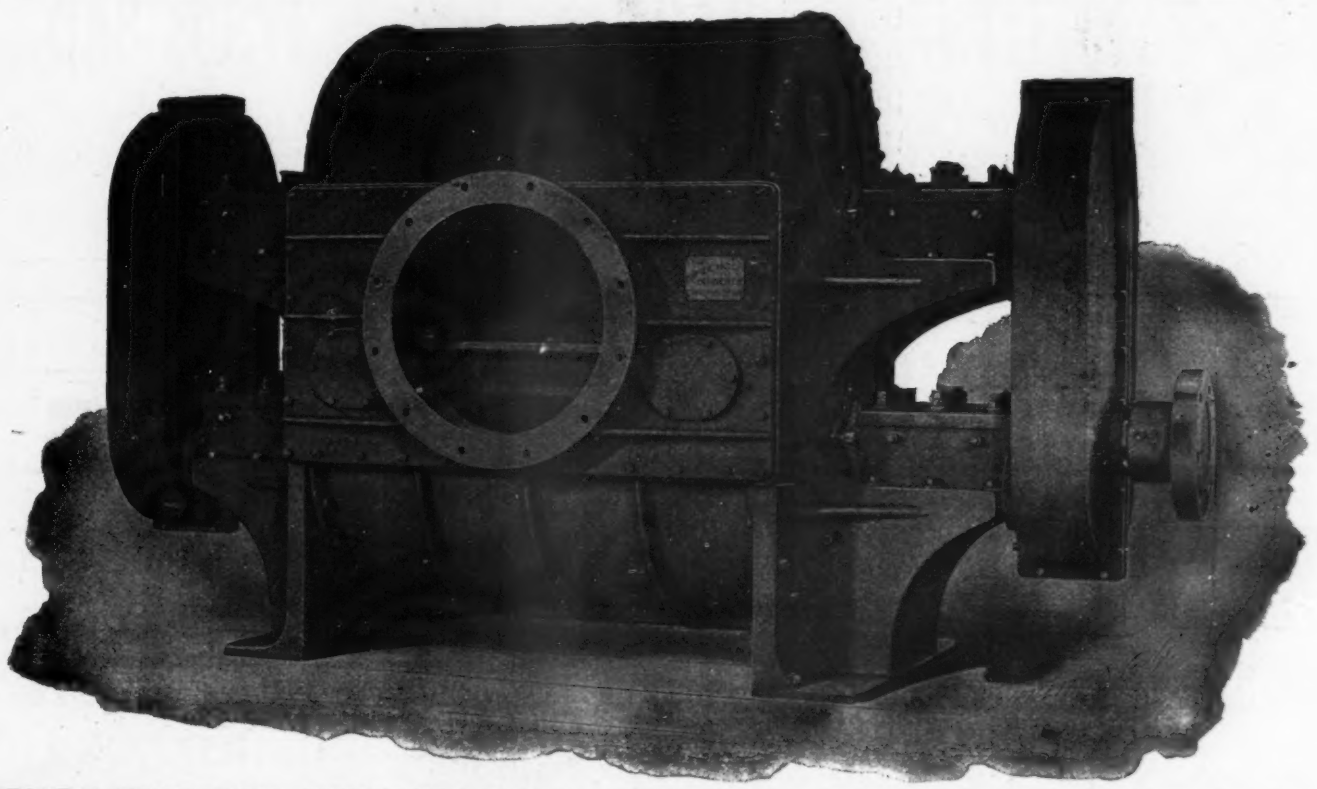

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